THE

ELECTRICAL REVIEW.

VOL. XLIX. DECEMBER 27, 1901. No. 1,257.

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THE

UNIVERSAL ELECTRICAL DIRECTORY

1902 Edition

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ELECTRICAL PROGRESS AND LEGISLATION.

IN an address delivered on Wednesday, 18th inst., before the Chamber of Commerce, Mr. R. Percy Sellon, chairman of the electrical section of that body, sketched the progress, or rather, as he would be inclined to phrase it, the lack of progress of electrical industries in this country. Considering the researches of Davy, Faraday and Tyndall, the practical applications of Wheatstone, Cooke, Thomson and others; considering also our free trade, unparalleled manufacturing facilities, capital resources, and control of important markets, Mr. Sellon urges that it would have been reasonable to prophesy our rapid progress and success against all comers in that revival of electrical enterprise which became imminent, when the Paris Exhibition of 1881 forced the world to realise that a new industrial era had dawned when the dynamo, the arc and incandescent light, and the telephone had assumed a commercial stage. Mr. Sellon is of opinion that we are both absolutely and relatively to other leading communities of the world in serious arrear of the position we should have attained, and he devotes his address to an exposition of the causes. Passing lightly in review the frequently referred-to early speculation, the unforeseen commercial expansion of America and Germany, the unfavourable labour conditions at home, and the alleged apathy of our electrical engineers and manufacturers, Mr. Sellon reaches what he regards as the prime cause. This is to be found in legislation. Prior to the era of electrical development already referred to, the State had purchased the telegraphs, and the introduction of electric lighting was unhappily at a period which saw the culminating point of those principles of collectivism or common ownership which, in the latter part of the last century, gradually impressed themselves on men's minds. Thus the principles applied to tramways in the Act of 1870 were applied to electric lighting in the Act of 1882, and when electric traction became a possibility, it found the Tramways Act a lion in its path. Now that the economical distribution of electrical energy over very large districts is rendered commercially possible, Mr. Sellon holds that we are on the eve of developments which constitute a new situation, and amendment of existing legislation is indispensable. The Light Railways Act, under which much electric traction work has been done, expires in 1902, and after "the proved failure" of the Tramways Act to do justice to electric traction, "it is impossible" that the latter should be allowed "to remain on the Statute Book."

We cannot attempt to summarise Mr. Sellon's address, which, as it is appearing in our other columns, should be perused in full. It is a very able statement of the case, and has added strength from the very moderation of tone and language adopted. As an indictment of municipal enterprise, it will have some adherents, and some opponents It will be interesting to have the case for the other side

fully and ably presented. The conclusion, in the main, is that the developments in electric supply and traction within the next 10 years will need so large an amount of capital, that, if entrusted to municipalities, it will make the total of local indebtedness much greater than the national debt. It is further urged that the carrying-on of such enterprises must divert the attention of the local governing bodies from those social and sanitary problems which should be their first care. The evils which are attributed to the State purchase of the telegraphs may readily be assigned to other causes, whilst much may be claimed for the public benefit resulting from that purchase. It is possible also to enlarge unduly on the evils of the Electric Lighting Act of 1882, but it is not necessary to go all the way with Mr. Sellon in order to help him on his road. There will ever be two schools of thought regarding municipal enterprise, and in the case of electrical enterprise, it is possible to refer to developments under municipal ownership for which there is no reason to be other than grateful. The two schools will not have settled their differences by 1902, and any immediate legislation will have to safeguard the interests of local bodies whilst affording facilities to private enterprise. It is thus possible that of the many millions to be spent, some may be contributed from both sources. The main question is the steps to be taken to remove existing disabilities. First to awaken the public to the existence of those disabilities. Our legislation is seldom too promptly attained, and the cancellation of existing law is perhaps slower than the enacting of a new law. Hence Mr. Sellon's address is an aid to progress which may be assisted by most of those interested in electrical business; those who may not agree with him on all points being fairly assured that in the case of any laws which may be enacted or repealed vested interests are not likely to be overlooked. Obstruction to progress, whether it exist in narrow municipal views or narrow municipal boundaries, must be removed. Freedom for the employment of private capital is not necessarily antagonistic to municipal enterprise, but a wider and healthier recognition of the rights and advantages of private ownership is well worth cultivating by the collectivists whose interest in a locality sometimes dulls their judgment. What is required is not so much a discussion on the line of demarcation between public and private work, as a recognition of the necessity for the removal of disabilities which are to some extent common to both, and Mr. Sellon has made an important contribution to that end.

Electricity Tariffs.

As during the summer the demand indicators at Brighton are cut out of circuit, it is correct to say that the Pier pays a flat rate of 1d. per unit. This must make the mouths of the Metropolitan consumers water. Although not mentioned in Mr. Wright's very useful paper, which we deal with elsewhere in this issue, we think that this fact shows that the Kapp principle must be taken along with the late Dr. Hopkinson's. It was not clearly brought out in the discussion last week, but some speakers hinted at the subject, that if plant has to be provided to meet the peak-load and some particular class of consumers never come in at all on the peak, then the latter should rationally be charged only at the follow-on price, which thus becomes an extremely low flat rate. Take the case of a ten-hour consumer, in his tenth hour he is called upon to pay 1·6d. per unit by the present Brighton tariff, although Mr. Wright's own "correct tariff" only requires 1·36d. As the production costs amount to 0·6d. and the total cost (including preparation costs) comes to 1·22d., he still pays a certain proportion against the stand-by charges. If, however, he is in no way responsible for the latter, then at 1d. per unit he yields a handsome profit, every penny representing $\frac{3}{5}$d. costs and $\frac{2}{5}$d. profit. Now it happens that one London supply authority charges 7d. initial rate and 4d. after for the hours of peak lighting load, and 2d. per unit on a flat rate for the supply (for any and every purpose) during the hours of daylight. Eventually, no doubt, the 4d. rate will be halved. Then a simple tariff of 7d. initial, and 2d. follow-on, will hold during the peak load hours of darkness, and 2d. as a uniform price during daylight hours, which fits in well with Mr. Wright's "ideal" tariff. By having two supply meters, one for the "day" and one for the "night" supply, with a single demand indicator in series with the latter, the consumer can tell exactly how his cheap and dear supplies compare. It is obvious that either a two-way change-over switch, with an additional contact, and operated by hand, may throw one or other of the supply meters into circuit; or if the meters of the Thomson-Houston or Vulcan type be in use, a clock time-switch may energise the shunt circuit of that meter which is intended to register, the main coils of the two meters being in circuit. In the latter case, however, the demand indicator will record the top or greatest maximum load ever taken, and not merely that of the load registered by the "night" meter, and which must have occurred at a peak-time period.

Electrical Accidents and their Prevention.—At a recent meeting of the Midland Counties Institute of Engineers, held in the Technical College, Derby, a paper by Mr. L. W. de Grave entitled "Investigations into Some Electric Accidents, and the Means of Preventing Them," was read. The author divided accidents into two classes, "shock" and "fire." Accidents from fire were caused by (*a*) short circuits, and (*b*) bad contacts. In enlarging upon the means of prevention, the writer stated that it might be said of electricity, as for steam, air, or rope power, that a plant, properly designed, erected, and maintained, was perfectly safe, except for gross carelessness. He then dealt with the technical details of motor and machine construction, and the proper provision of switches. Materials for the insulation of wires were suggested, and he recommended the Sylvester method of artificial respiration for accidentally electrocuted persons. Mr. Deacon said that he found the best means for protecting workmen against electric accidents in mines was to lay the wires underground, in a puddled-clay trench, sufficiently covered to allow traffic over them without injury. Mr. Binns (Derby) observed that the Paris police were instructed in a special method of restoring electrocuted persons. Mr. de Grave replied to the remarks that had been made. Concentric cable was, in his opinion, the best to use. He had used it for many years without having known a single accident. Mr. Deacon's suggestion of burying the wires in the middle of the road was a very good one; he had used it himself, and found it answered admirably. India-rubber gloves he considered dangerous, for even if they contained a pin-hole they were highly dangerous; as much so, in fact, as if the wearer had an ordinary covering to the hand. In one works he knew of, where gloves were worn by the men, each pair was before being used always subjected to a compressed air test. There was the additional drawback, that the wearer was always "all thumbs." It followed that the person who was not fully developed would not experience the same severe contraction in respect to the muscular system. He cited the case of a man who received a shock and lived for only 10 minutes afterwards, in spite of artificial respiration. The coroner's verdict stated that death was due to shock. As a matter of fact, the deceased died from suffocation pure and simple, the attendants having neglected to unroll his tongue, which had become contracted and stopped the breathing. The discussion on the paper was adjourned till the next meeting.

SPRAGUE MULTIPLE UNIT SYSTEM.

As Applied on the Boston Elevated Railway.

By FRANK J. SPRAGUE.

(*Concluded from page* 1047.)

The master switch has (1) the off or normal position, to which the handle is spring-retracted in case the operator lets go of it; (2) for ahead movement, three running positions, coast, series and multiple or full speed, with no contacts between; and (3) for the backward movement, two running positions, coast and series or half-speed position. The car can be stopped and reversed by a single throw of the handle of the master switch from one side of the open position to the other.

Ordinarily, when a motorman wishes to go ahead at half speed he moves the master switch to the series position. The reverser is instantly set for movement ahead, the series relay is closed, the pilot motor starts up, the driving spring is put under tension, and the controller spindle moves forward intermittently until the pilot limits stop it at the half speed position. If, during this operation, the throttle should lift, this advance of the controller cylinder will be retarded or stopped. If the automatic stop should drop, the advance not only will be stopped, but the controller will at once run backward to an open circuit or other determined position without regard to the set of the series relay, or the wish of the man at the master switch.

Being at the series position, if the motorman wishes to go at full speed, the handle of the master switch is moved to that position, when similar operations take place at the relays and pilot motor; or the operator may move his switch handle at once from the open circuit to multiple, without regard to series, and the main controller, controlled by the throttle, will advance to full speed position. Of course, the advance of the main controller may be made at will, step by step, by touch-and-go contact at the master switch, and its advance can be arrested instantly. If desirable, when a coast relay is used, its connection can be changed so as to, at will, throw the throttle out of action, although this is not desirable.

Comparison of the movements of the master switch and the main controller illustrates very clearly the inter-connection of controlling circuits and their utility, and how they are intended to provide for every emergency whatever. To all apparent intents and purposes the controller seems possessed of an independent intelligence, because the relay system and the interconnection are such that all local emergencies are provided for, as they must be, without regard to the wishes, intents, or carelessness of an operator.

The description thus far is that of the operation of a single car. To connect two or more cars together, and to provide for the initiation of the operation of the controllers on such other cars as may be fully equipped from one or more of the master switches, as well as to transmit control through cars not equipped with motors, the independent train line is provided, which is the extension of the platform-switch circuit from car to car, through fixed train cables on each, terminating in couplers at the ends of the cars, and flexible and reversible train cables, or jumpers, terminating in couplers with complementary contacts, and serving to join the several train cables together at the ends of the cars. These train lines and jumpers are so connected to the coupling heads that the controlling circuits are automatically paired to ensure proper operation of the various main controllers for any master switch without regard to what are the abutting ends of the cars, their number or sequence, or how the jumpers are reversed, or whether, as in practice, they are coupled indifferently on one side or other on the cars.

While some roads only change sequence of cars in the make-up of trains, in many they are reversed, as in the operation of open-end relays, cross-overs, loops and yards. Therefore, in addition to general pairing of the sets of speed and direction circuits, the individual speed circuits must always be paired alike, while the individual direction circuits must at times be changed in connection. Provision is made so that local circuits can be cut off from the train line and independently tested.

Normally, then, movement of any master switch (the others for the time being inoperative and held at open circuit) closes like relays on each car and starts the sequence of operations indicated for a single car, but here also the automatic variation of movement described in regard to a particular controller takes place independently at each car, and different kinds and degrees of movements of the controllers of different cars can take place simultaneously if necessary. Not only that, but to provide for difference of wheel diameters, difference of tractive coefficients on different wheels, and to provide also against any irregular condition on any car, similar movements may be differently timed, and different controllers may take different relative positions when measured by time, each accommodating itself to the limited current input determined for itself.

It therefore becomes possible by this combination of positive and semi-automatic control to combine cars having controllers of different sizes, motors of different capacities, resistances of different gradations, gears of different ratios, and wheels of different diameters, and to safely operate them all from one or more controlling points, all of which, of course, would be absolutely impossible to a hand-method of control, or anything approaching to it.

Current Supply.

Current for the Boston Elevated service is delivered from the stations as follows:—

Stations.	Maximum capacity. Amperes.	Circ. mils. elevated feeders.	Feet to elevated structure.
Central	40,350	8,000,000	800
East Cambridge ...	7,650	6,000,000	5,000
Charlestown	4,350	4,000,000	1,000
Lincoln	21,150	20,000,000	200

Reference to this table will show the possibility of current flow which would follow a short circuit on the elevated lines. By reason of the grades and alignment of the system, and the high speed and frequent service maintained, the fluctuations of load are severe. As the stations feed both elevated and surface lines, the fluctuations due to the elevated service are taken care of without difficulty. Observations so far made indicate that the current demand for a section of the elevated line 1½ miles long, having in operation nine trains, varies from 500 to 6,000 amperes. Even with such demands for current the minimum voltage at the contact rail is 500 volts, because of the large section of feeders and the proximity of the power stations. The feeders used are of 2,000,000 circ. mils. section, and are run in conduit to the structure, where bare tin-copper cables mounted on glass insulators are used. They are covered by a cable box, the top of which forms a convenient walk on the structure. The several sections of the contact rail are tied together by enclosed feeders of 2,400 amperes capacity.

Some of the elevated and surface line sections are fed from two or more separate stations. This ties the stations together, and distributes heavy pulls among the different stations. To further assist in this distribution of "pulls," the generators are given a drooping characteristic. Thus, when an extremely heavy pull occurs in close proximity to one station its voltage falls, and the other stations assist in carrying it. In addition, if any station by reason of locally heavy traffic is overloaded, a portion of its load is shifted to other stations by voltage reduction at the generators by the field rheostats. The feeder system is carefully laid out so that any section may be cut out without interfering with the operation of the rest of the system. In order to prevent the contact shoes bridging from a live section to one in trouble, a rail of suitable length fed through permanent resistance is inserted between the two sections. Specially designed "protected" rail-bonds are in use for feeder taps to the contact rail. The track is bonded to the structure to provide an efficient return circuit.

The Lincoln power station is the one most recently built. It is thoroughly modern in every respect. Vertical engines direct connected to generators of 2,700 KW. normal capacity are used (see fig. 15). The ultimate rated capacity of this station will be 18,900 KW., with ability to carry for one hour 28,000 KW., and for brief periods 38,000 KW. During acceleration

each car, which weighs empty 59,000 lbs., and has 63½ per cent. of the weight on the drivers, takes a maximum of 550 amperes, and an acceleration of 1·8 miles per hour per second is obtained. The maximum speed reached between stations is 46 miles per hour. The acceleration is uniform, and the track is of such excellent construction that it is most difficult to realise the high speeds that are obtained.

As near as has been determined, the energy consumption per car-mile is 4·5 KW.-hours. The present mileage is about 20,000 car-miles per day. The grades encountered and the high speeds run are reflected strikingly in the extreme wear of the brake-shoes and wheels. The shoes first used were completely worn out after 200 miles of service. Special shoes are now used, and longer service is secured. This also means exceptional wear on the wheel tires.

One run, that from the Boylston Street (Subway) station, also well illustrates the difficult character of the service. From this station descent is made down an 8 per cent. grade

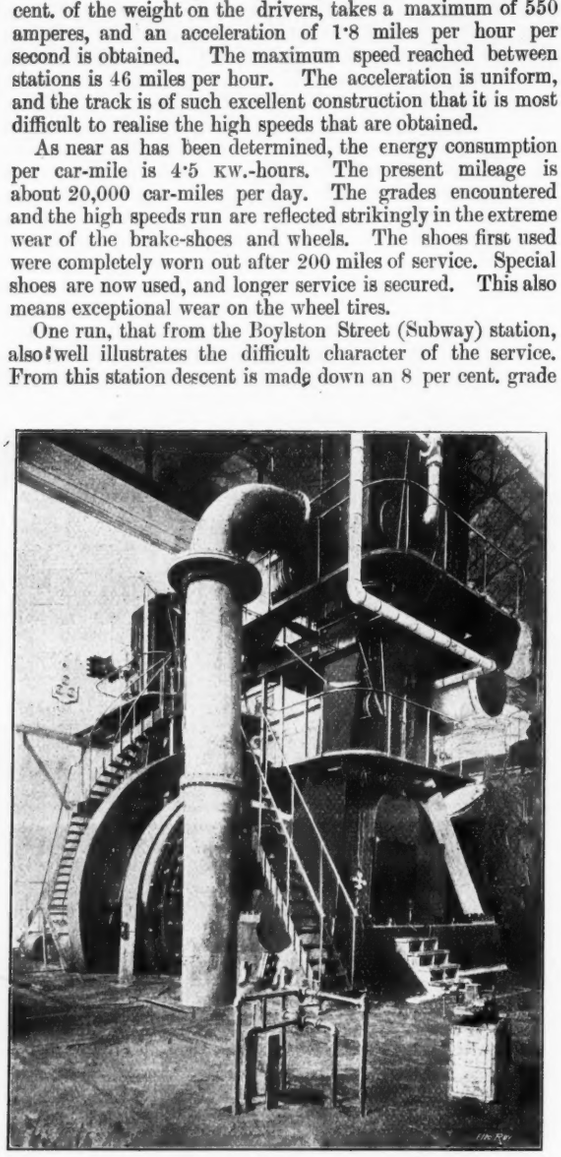


Fig. 15.—2,700-kw. Steam Dynamo.

round a sharp reverse curve without connecting tangent, round other curves and over a changing grade, ascending 4·5 per cent., descending 3 per cent., ascending 2·9 per cent., descending 3 per cent., ascending 5 per cent., then finally descending 1·5 per cent. to the Pleasant Street station, located just outside the subway, at the foot of the incline to the elevated structure.

The passenger traffic is especially complex, because of the system of transfers. At one station these are isused to no less than 37 lines of surface roads radiating throughout the city. At the northerly terminus connection is made with 16 lines of surface cars running to the suburbs, and here as many as 24,000 passengers in an hour, and 125,000 in a day, have been transferred. At the southern terminus connection is made with 34 lines of surface cars, and there is here also a heavy transfer of passengers.

These brief statements will indicate the extreme density of traffic over the whole line, and how imperative are the appointments for the safe and rapid handling of the service. Not the least important are the platform arrangements necessary to care for such traffic. At the terminals, and also at the busy stations in the subway, free access on the same level is given between elevated and surface cars. At other points ticket transfers are issued to and from the street. The traffic has so far exceeded all expectations that both the platform gates and centre doors are used at all stations. On each platform opposite the car entrance is painted "Enter here," to ensure the prompt loading of passengers. By printed notices in the cars and signs at stations passengers are requested to leave the cars at the centre door and enter at the gates. At each station the trains are rung off by a large gong. The gates are then shut immediately, and the station stops are thus reduced. There has been a most marked development in the alacrity which the patrons of the road have attained in entering and leaving trains, and the positive manner in which the gates are shut on signal has much to do with this. The smoothness of operation, and the speed of the trains, have served to make the service very popular.

Plans are being made for the extension of the elevated structure and for the construction of an additional subway. The future will doubtless see no less than 50 miles of elevated track and 600 cars in operation.

The equipment and operation of this system in its entirety is of the most advanced type, and reflects the highest credit upon the officers and engineers of Boston Elevated, who have had for solution a problem of unprecedented difficulty.

THE TESTING AND MANAGEMENT OF ELECTRIC MOTORS.

By P. T. WHITE, Wigan Electricity Works.

It has always appeared to the writer a matter of deep regret that persons of an ultra-mathematical, but otherwise well-meaning disposition, should endeavour to befog the simplest operations of central station testing with involved algebraic formulæ. "Figures can be made to prove anything," especially when one can introduce those God-sends of the "mixed" mathematician—constants—often, alas! of a home-built and rectifying nature.

Of such, I am assured, are the formulæ :—

$$C = \frac{\sqrt{E^2 - 4\,(W + w)\,r}}{2\,r}$$

$$\text{Per cent. efficiency} = \frac{100\,W}{E\,(C + C_f)},$$

and the methods of testing appearing in a recent issue, as an abstract from an American contemporary, under the heading "Electric Motor Testing without a Dynamometer." The efficiency of the machine considered is stated as 86·037. It is a pity that the result was followed to three places of decimals only. In my opinion it should have been pursued to the bitter end—or a "repeater."

Although it is now many years since I left the *calculus* behind me, and even now I seldom employ algebra in my everyday calculations, I have little hesitation in stating that the efficiency of that motor is nearer 88 per cent.

The best method of testing an electric motor is to put an artificial load upon it, and determine the mechanical torque of its armature as expressed in the output of a driven machine whose dynamic efficiency has been found by some common-sense method. In the article referred to we were asked, among other things, to secure the armature shaft, and connect the brushes to the circuit through a resistance, so carefully adjusted, that a D.P. of 220 volts was toned down to ¾ volt. Then, with

$$(E - v)\,c,$$

we got the armature core and friction losses in watts. After both these feats, and the first is no small one, I thought I had "arrived," but my hopes were dashed to the ground, so to speak, when I read "the formulæ for full load current are based upon the assumption that the core losses, armature friction, windage, and pole-piece eddy current losses all remain constant from no load to full load. While this is not strictly true, the error introduced is practically negligible." Certainly; but had it not been so negligible, he might have had to introduce a few more decimals into his computations. In passing, may I commend some similar method to the gentlemen who write you *re* their coal consumption per unit of output.

As already stated the "artificial load" method is at once the best, and the one most generally employed. When a testing tank is employed, the greatest care is necessary. In no instance, and the writer speaks from painful experience, should such a test be left in the charge of a careless and foolish man. Even when the dynamo side of the combination is properly equipped with cut-outs or circuit breakers, care is necessary. When it is not, disaster is invited. In some so-called tests witnessed by the writer, it was not even deemed necessary to put an ammeter in circuit. A voltmeter had, however, been put across the dynamo terminals, and the operator was somewhat distressed to find that a few minutes from the start his volts began to drop rapidly. He came to the conclusion that this was due to the belt slipping, and went forth in search of some resin, to return and find the armature of a valuable machine burned out. It cannot be too strongly impressed upon the man who essays this form of testing for the first time that an ammeter and proper cut-outs are absolutely necessary. It will pay to fit up a properly equipped testing board even when very little testing is done.

A method, even better than the "pond," is to utilise the station lighting and power circuits. These circuits are usually made up on a board in such a manner that they can be transferred from one side to the other of the three-wire system to assist in maintaining the balance. It may readily be assumed that all motor-testing operations will be conducted during the daytime, when the station circuits can best be employed for the purpose. Where the station is in embryo, or in course of erection, it will pay engineers to design a board which will meet these special requirements, and even where the station is completed, methods of re-arrangement, at trifling cost, will readily commend themselves to practical men. In small stations where the number of motors to be tested is very small, it will pay to make up temporary circuits of arcs, incandescents, and the shunts of other motors. Whenever it is posssible, it would be well to conduct the testing of apparatus furnishing the load at the same time. Meters, for instance, which, in some stations, are never properly tested (too much reliance being placed upon the maker's test scrip), can be included in the circuits.

An important adjunct of any station with pretensions to a power load is a small alternator of, say, 15 to 25 H.P., having a terminal voltage of 2,000 or 3,000. With the help of this, it will be easy for an engineer to reject faulty machines before expense has been incurred upon them; 2,000 volts alternating between windings and frame will soon bring to light—in more ways than one—the weak points in a bad machine. Of course it is evident that several machines can be submitted to this test at the same time.

This brings me to the discussion of another method of testing motors, and one which I should wish to see more in use. With the help of a short countershaft having different sizes of pulleys to suit the varying speed requirements of different motors, the alternator can also be employed to furnish a load of incandescent lamps through a suitable transformer. I see no reason why the required load should not be the station lighting load, though I am aware that many engineers will rise in arms against this. The pressures of both systems would be the same, or nearly the same, and, even if they "clashed"—and with proper precautions this should not occur—nothing more serious than a bad flash would result. Of course it will be understood that fusible cut-outs only, and not circuit breakers, are to be employed. There is, however, the rather remote danger of the high-tension primary invading the secondary circuit through a transformer breakdown; but even if this did happen the trouble would only be momentary. The alternator and motor fuses would instantly go. There is, I am aware, in the minds of many station engineers whose knowledge of alternating currents is limited, and whose practical experience of same *nil*, a decided prejudice against their employment. This may be attributed to their fear of accidents from shock. Naturally, where high potential currents are employed, the greatest care must be taken to avoid "getting into" the circuit. There cannot be a doubt that nowadays safeguards are adopted which, to a large extent, prevent the recurrence of the many fatalities which marked the progress of the industry in its early days. "Live metal" at high potential is generally inaccessible to any but the criminally negligent, but in the old days this was not by any means the case. The writer has been "in" a 2,500-volt circuit, and even though this was many years ago, has no desire to repeat the experiment. Notwithstanding this, there is no "cussedness" whatever about the alternating current. Intelligent care is all that is needed. Even "three-wire" men experience no anxiety to get across the "outers" of their system, though, in a station, these are *not* protected.

(To be continued.)

LOAD FACTORS AND CIRCUIT BREAKERS.

By AN ENGINEER.

It may have been observed that in the discussion of load factors, any attempt to formulate a rule is based on the assumption that cars will not all start and stop simultaneously, and there appears a tendency to consider that there is a great probability of all the cars starting up together. Were this assumption true, the load factor for 100 cars would be exactly the same as that for only a single car, the same, that is, for the engine load, beyond the frictional resistance, and actually the same for the switchboard load. My own determination of load factor for a system of one car is from 10 to 12 per cent., and if, on a system of 100 cars, every car did start and stop absolutely synchronously, the load factor could not exceed the same low figure. It has been argued that because the turn-outs of a tramway are laid out with a view to exact timing, this is the result attained; but I maintain that no such result can be secured by the most intelligent and careful calculation, for it is impossible to take into account the infinite personal matters that interfere with the attainment of a calculated effort.

A close approximation to practically perfect car running may be secured without in the least interfering with the load factors as determined by the formula I have suggested. A difference of a few seconds only in the starting of a dozen cars will be quite sufficient to reduce starting currents to a moderate aggregate figure. Actual autographic records of the current consumption of cars started from rest, do not show an initial rush of current on the first controller notch of any particular severity. Indeed, it appears from numerous records that the first series notch allows less current to pass with a car starting from rest than will be consumed by a running car on the parallel notches. The jump to the parallel running first notch is larger than the jump from zero to the first series notch.

A very slight incident will disturb the synchronous starting of a lot of cars. The presence or absence of passengers, the delivery of a parcel by the conductor, or the slow movement of a stout passenger, will serve to throw cars out of time. Observation of the switchboard instruments of numerous tramways, and of the autographic tapes, will show conclusively that the load factor does naturally and markedly improve with the number of cars at work. It is not denied that there is an occasional flush of current that *would*, perhaps once, perhaps 10 times daily, show a maximum load far beyond anything covered by the load factors I have sketched out. I italicise "*would*" designedly, because these heavy currents do not require to be allowed for in practical working. The maximum load that practice has decided upon as allowable, and as really determining the load factor, is that which can be suffered to occur many times daily. Any further maximum is disallowed by the main circuit breaker, for this is set to act in a way to forbid the severe effects of an occasional simultaneous starting of many cars. These simultaneous startings are more apt to occur when cars are fewer, and embrace a larger proportion of the total load, and this is why it is that circuit breakers must be set proportionately higher for few than for many cars.

Too much stress, also, must not be laid upon the effects of starting current in producing a heavy station load. The starting current on the first series notch of a controller is not above 10 or 15 amperes in a single-truck car on a level, and is of less moment than the sudden jump which takes place when the controller handle is passed to the first parallel

from the last series notch. Now, this operation is performed many times, as a rule, between each start of a car from rest, and has a greater effect on station output. It is obviously very unlikely that cars will synchronise either on starting times or in parallel working, and therefore, with judicious fixing of the automatic cut-out, the maximum station output is controlled within selected reasonable limits. The setting of the main cut-out is not usually accorded much serious thought. It is, however, a matter of real importance. If set too low the cut-out will act too often ; cars will constantly find themselves without current, and the engines will be too frequently running at no load. The load factor will be improved if the circuit breaker is quickly put in, as it should be, for, in most cases, the acting of the breaker is due to causes that are momentary in effect. On the other hand, when circuit breakers are set unjustifiably high they will rarely act, and will expose the machinery to unnecessary and undesirably high stresses. At the same time the load factor will be reduced, and the economy of the station impaired.

Between these two extremes there is a point at which the instrument should be set by experiment. It should always be set low to begin with, that is to say, it may be set to act when the current is from 50 to 30 amperes per running car, according to the size of the station. If, with the first setting, it acts too frequently for the convenient working of the station, it may then be screwed up to a higher pitch. but not so high that it ceases to work from time to time, When fairly adjusted, the instrument fulfils the double purpose of safeguarding the machinery and pointing out unusual shorts.

In working out load factors, it does not appear possible to work upon any assumption as regards turn-outs or simultaneous starts, or, indeed, on anything of the nature of mere assumption ; but it appears rational to base calculations upon approved averages. From careful observations upon a considerable number of running tramways extending over many months, it is apparent that the mean average of all conditions on numerous lines of very different types, working under conditions as widely different as will usually obtain, is remarkably amenable to calculation by purely empirical methods. Variations will, of course, occur in different systems, due to different settings of the main circuit breaker, but such variations are not so wide as seriously to impair the value of an approximate formula. It is for this reason that car-hours and the average number of running cars should be known, for these figures are of more engineering value, if, indeed, not of more financial value, than mere car mileage. Car mileage and units consumed per car-mile are usual statistics to be given, but they are of small value taken alone. Unless car-hours are known, the mean speed of the cars cannot be ascertained, and it is impossible to draw conclusions from the units per car-mile.

The loss of energy due to frequent stops accounts for a considerable proportion of energy consumption, and it by no means follows that a high average speed implies more units per car-mile, the tendency, perhaps, being rather the other way, owing to the conservation of energy otherwise dissipated by frequent braking.

To sum up, while the heavier draughts of current by several cars may occasionally synchronise, all such efforts are preferably to be eliminated by the action of the circuit breaker, this serving to cut off the high spikes of the autographic record, and reduce the maximum flow of current to such a multiple of the mean current as practice has shown to be reasonably consistent with convenience of working, and the safety of the station. The circuit breaker, in fact, seems to effect the best compromise between opposing interests.

The importance of a fairly approximate prognosis of the load factor, and the average current per car, extends beyond the design and provision of the station outfit, for upon it hangs largely the design and copper contents of the distribution system, and, indeed, the whole general economy of the system and works. The rapidly augmenting weight of later cars will materially affect total current consumption, but probably it will have but small effect upon the load factor, seeing that this is dependent upon the number of individual loads, rather than upon the size of such loads. Still it is desirable that statistics should be kept, and made available for all running systems, showing all the conditions and the power consumption, car hours and mileages, &c., without which knowledge design must be more or less a matter of guesswork. That guesswork has been one of the main factors in power station design is very evident when stations are compared and their working figures studied.

The very perfunctory attention at times accorded to the circuit breaker is evidence that its proper and complete functions are not always understood as they should be. A circuit breaker is too often regarded simply as a device for taking care of short circuits and cable damages. Quite as important is it that it should cut off what would be the excessive spikes of the load diagram. Though the general maximum load will be that which occurs frequently and almost periodically, and should not start the circuit breaker, there will be occasional car coincidences in respect of heavy demands of current that must be eliminated. It is not desirable that on an up-grade of considerable angle a car should be deprived of power. It is, therefore, right that lines of severe gradients should be allowed a higher maximum current than is proper to more level systems. This necessity is moderated by the fact that the excess of up-grade car demands is more or less balanced by the down-grade cars ; but it is probably on the side of safety to allow a poorer load factor in hilly country, as safety is better ensured thereby. This need not necessitate any special calculation, as the proper allowance will be secured by experiment, the circuit breaker being adjusted to the conditions that show themselves when a line is set to work.

If the arguments here advanced have a sound basis, it is evident that there is a close connection between the load factor and the circuit breaker, and that judgment is necessary in estimating the limit of economy at which a station can be suffered to work without impairing its convenience or its safety.

CONTINENTAL ELECTRICAL FINANCE.

A Possible Pause in Germany for Some Years.

The electrical engineering industry of Germany, as is well-known, has not been exempt from the general economic depression prevailing in that country, but according to Herr Rathenau, general director of the Allgemeine Elektricitäts Gesellschaft, of Berlin, the future outlook is not of a promising character. In addressing the shareholders a week or two ago, he expressed the opinion that a pause in activity had arisen which may extend over several years. This observation should be taken as one of general application, and not as specially applied to the particular company in question, which is exceptionally situated in consequence of its many ramifications throughout the world, which result in the receipt of orders in regular sequence, although at present not to the same extent as in the high period of prosperity. As to the proposed working agreement with the Schuckert Company, Herr Rathenau stated that the negotiations have for the time being only led to an approachment of the directors of the two companies, but he was unable to say whether an agreement would be arrived at eventually. Since this speech was delivered, it has been reported that no arrangement has been come to, and it is assumed that no effect will be given to the preliminary negotiations. The pessimistic view entertained by the general director of the A.E.G. is apparently shared in other directions, as one of the trust or investment companies considers that little improvement will take place until the question of main line electric working has been satisfactorily solved. This is, of course, a large order, although the fact cannot be overlooked that the results of the experiments on the Zossen military railway are being awaited with considerable interest. It would be a difficult matter to forecast the future, but it is certain that the events of the past few months will reduce speculation to a minimum for some time to come. The next year or two will be a period of severe trial, and it rests with the manufacturing companies to restore the confidence which some of the trust and promotion companies have caused investors to lose in the matter of electrical securities. Next to Germany a good deal of solid work has been accomplished in Switzerland, where the hand of the Teuton is being manifested, as also in other parts of Europe, and reference to some of these instances is made below.

The directors of the Siemens & Halske Company, of Berlin, have not yet issued their report for the financial year ended June 30th, although they have intimated their intention to propose a dividend at the rate of 8 per cent., as compared with 10 per cent. in the previous year. In this connection it is to be noted that on the present occasion the entire capital of £2,725,000 will participate in the distribution, whereas a year ago the full dividend was payable on £2,250,000, and 4 per cent. was paid on £475,000. After providing for depreciation, the balance to be carried forward to the next

account amounts to £69,906, as against £69,359 in the corresponding year. At the end of the financial year the company employed 13,886 officials and workmen as compared with 13,628, whilst the number increased to 14,374 at the beginning of October of the present year.

The Electrical Installation Company (Aktiengesellschaft für Elektricitatsanlagen), of Cologne, which is the trust company of the Helios Company, has emulated the latter in incurring an enormous loss during the past financial year. In the year 1898-99 a dividend was paid amounting to 6 per cent., and in the following year the profit realised was devoted to the purpose of writing down the value of securities owing to the losses on the market quotations. The prices of the company's investments have, however, further declined during the past year, with the result that after meeting this depreciation and absorbing the reserve fund, there is found to be a deficit of £266,762 for the year on a capital of £800,000. At the recent general meeting proposals were made in favour of the formation of a committee of revision, but these were eventually withdrawn, and the directors intimated that a scheme of reorganisation would be proceeded with as soon as the situation of the market allowed of that being done.

The Mannheim Telegraph Wire and Cable Company (late C. Schacherer & Co., of Mannheim-Waldhof), which was formed two years ago with a capital of £50,000, has made little progress during the past year. A slight loss was incurred in the first year, and, although it was possible to get the factory in operation for six months of the second year, the result has been a deficit of £971. Since November, 1900, a community of interests has existed between the company and the South German Cable Works of Mannheim, in so far that a mutual exchange of shares has taken place, and some of the directors of either company have been transferred to the other.

Switzerland.

The first annual report of Brown, Boveri & Company, of Baden, as constituted under joint stock auspices with a capital of £500,000, reveals a net profit of £90,840, out of which a dividend at the rate of 16 per cent. has been declared. Although a company, the shares are held only by a limited circle, which is fully acquainted with its internal affairs. During the financial year the works were fully employed, but prices continually receded in consequence of the general depression. The business in Switzerland was largely prejudiced owing to the crisis in the carbide of calcium industry, but the settlement of contracts for carbide works has been completed without noteworthy losses. A remarkable fact is that although a Swiss Company, only about one-fifth of the output is disposed of in the country. The report characterises the position of affairs in Germany as more unsatisfactory than in Switzerland, and states that some of the companies have so largely increased their productive capabilities as to be unable to find remunerative business under existing circumstances. Nevertheless the company has carried out several important installations in Germany, whilst large installations have also been completed in France and Italy. As far as investments are concerned, the company is largely interested in the Brown, Boveri & Company, of Mannheim, the Motor Company, of Baden, and the Compagnie Electro-Mecanique, of Paris.

The Oerlikon Engineering Works (Maschinenfabrik Oerlikon), in which the A.E.G., of Berlin, was largely interested until recently, has a capital of £240,000, and at the annual meeting a proposal will be submitted for increasing it to £320,000 in order to deal with the extended scope of business. Notwithstanding the existence of general economic depression during a large portion of the financial year 1900—1901, the company is enabled to show slightly improved results over the previous period. For instance, after writing off £25,600 for depreciation, or practically the same as in the preceding 14 months, there remains a net profit of £32,300 as against £30,050. It is proposed to pay out of the net profits a dividend at the rate of 10 per cent. as in 1899—1900, although the capital participating in the distribution is considerably higher on the present occasion. The company's report complains of increased competition and states that the reduction in the cost of raw materials, with the exception of coal, has been counteracted by the decline in the price of manufactures. New business connections have been inaugurated during the year which now give the undertaking a cosmopolitan character. A branch office has been opened at Lausanne, the company is at present represented in Italy by a legally independent Oerlikon Company in Milan, and the Spanish sales department is administered by a company closely allied to the parent concern, and all three branches have already been productive of satisfactory orders. In addition to these the Société Russo-Suisse Oerlikon has been formed, with a capital of £40,000, and the offices in Moscow and Warsaw will commence operations as soon as the requisite concession has been received from the Russian Government, whilst the company's first transmarine agency connections have been negotiated during the year. The new year has been opened with a sufficiency of work, although at depressed prices, both for machine and dynamo construction, and important orders for the new branch for the building of turbines have also been received.

The Franco-Swiss Electrical Company (Société Franco-Suisse pour l'Industrie Electrique), of Geneva, is largely interested in various industrial undertakings, although the company's report for the past year does not specify the amount invested in individual enterprises. It has a share capital of £1,000,000, and a year ago a dividend at the rate of 4 per cent. was distributed. The past year's operations have resulted in a net profit of £47,760 as compared with £53,790 in the preceding 12 months, but it is not intended to pay any dividend on the present occasion. This is doubtless due to the fact that many of the works in which the company is interested are in course of being carried out, but these undertakings will only be affected by the existing crisis should it become accentuated and be prolonged to the time when they are brought into operation.

The Bank for Electrical Enterprises (Bank fur Elektrische Unternehmungen), of Zurich, and the Swiss Company for Electrical Industry (Schweizerische Gesellschaft fur Electrische Industrie), of Basle, are the two principal promoting or investing companies in Switzerland. The former, which is intimately connected with the Allgemeine Company, of Berlin, has paid a dividend of 6 per cent. for the past financial year as against 6½ per cent. Messrs. Siemens and Halske, of Berlin, are closely associated with the Basle company, which has distributed 4 per cent. as compared with 6 per cent. in the preceding year.

The Rheinfelden Power Transmission Company (Kraftubertragungswerke Rheinfelden), which was formed in 1894 for the purpose of utilising the water-power of the Rhine at Baden-Rheinfelden on the Germano-Swiss frontier, has just offered for subscription a 4½ per cent. loan of £200,000 in order to repay an advance of a similar amount made some time ago by a banking syndicate in conjunction with the Allgemeine Elektricitäts Gesellschaft, of Berlin, the founder of the company. At present the ordinary share capital reaches £300,000, and the dividends paid have been 4 per cent. in 1897 and 1898, and 5 per cent. in 1899 and 1900. There is no time limit for the company's concession on the Baden side, but it has been fixed at 90 years from 1898 on Swiss territory. Of the 20 turbines in operation, 10 have been leased for the whole period of the concession to the Neuhausen Aluminium Company and the Rheinfelden Electro-technical Works, in return for the payment of the lump sum of £150,000 and an annual contribution of £500. In addition, power is supplied to other works, and 16,000 glow lamps are connected to the distributing network, whilst a further instalment of plant to the extent of 1,000 H.P. is proposed to be erected.

Other Countries.

One of the most recent promotions in Spain is the Sociedad General Espanola de Electricidad A.E.G., of Madrid. As indicated by these initials, the company is related to the Allgemeine Elektricitäts Gesellschaft, of Berlin, which, in conjunction with its Iberian representatives, is the real founder of the concern with a capital of 1,000,000 pesetas. Messrs. Levi & Kocherthaler, of Madrid, the present agents of the Berlin company, will continue to represent it in Spain and Portugal independently of the new company. A second enterprise is the Société Ibérique Thomson-Houston, which has been constituted in Madrid, with a capital of 10,000,000 pesetas. This company acquires the Thomson-Houston patents for Spain and Portugal, and takes over the concession for the tramway at Cadiz and the lines in process of conversion at Valencia.

The Austrian Schuckert Company, of Vienna, which has a capital of 8,000,000 crowns, has a satisfactory record for the past year, the dividend being at the rate of 7 per cent., as compared with 6 per cent. in the previous 12 months. The net profits amounted to 699,550 crowns, as against 464,853 crowns, and the prosperity of the undertaking would appear to be largely due to the fact that the company is solely engaged in the supply of plant and the execution of works in connection with central stations, electric tramways, and power transmission and lighting schemes. At present the company is equipping the Vienna municipal power station for the operation of the tramways and the municipal lighting station. The growth of this Austrian branch of the German parent enterprise is shown by the fact that at the end of the financial year the company had 1,162 workmen in its employ, or an increase of 346 over the preceding year.

The Liège International Electrical Company, of Liège, has declared a dividend at the rate of 6 per cent. on the original capital of 5,000,000 fr., as against 10 per cent. in the previous year, and of 6 per cent. on the new capital of 1,280,000 fr. The company's report refers to the opening of a branch establishment in London for the purpose of extending its business in the United Kingdom, and mentions that the Paris branch has resulted in a profit of near £1,800 for the year.

The Russian General Electricity Company, of St. Petersburg, is the title of a new company formed apparently for the purpose of taking over as a Russian company the branch establishment founded in that city by the Allgemeine Elektricitäts Gesellschaft, of Berlin, in 1898. The latter company is the promoter of the new concern by the intermediary of Herr Emil Rathenau and Herr M. O. Dolivo-Dobrowolski, and the capital of the company amounts to 1,000,000 roubles, divided into 4,000 shares of 250 roubles each.

INSTITUTION OF ELECTRICAL ENGINEERS (NEWCASTLE SECTION).

Abstract of Address by the Chairman, Mr. John F. C. Snell, on Monday, November 18th, 1901.

The applications of electricity are becoming more universal every year, and must become eventually as universal as are those of steam and gas to-day.

It is simply a question of time, but it will inevitably come just as all other known things in this universe evolve from a less to a more efficient condition.

I am often asked by people who wish to know how their sons can

become electrical engineers, and by students already entered upon their professional career how they can specialise for one of the many branches that are open to them. In addition to advising the scientific subjects which they should master, it is important to remember that at the root of all lies the fundamental necessity of real work, not only to make money, but much more to assist—be it ever so slightly—to develop applied science for the advancement and improvement of one's fellow creatures.

I will now pass on to that branch of electrical engineering in which I have been engaged., viz., the distribution of energy from central generating stations.

No less than 81 municipalities have installed their own electrical undertakings, representing a total of 163,000 H.P., with a capital expenditure of £10,360,000; as well as 44 companies, representing 110,000-H.P.,with a capital of£9,105,000; or, added together, there is no less than the sum of nearly £20,000,000 invested in electrical undertakings for the distribution of energy from central stations.

Roughly, these figures represent £63·5 per H.P. installed for municipalities, and £82·5 per H.P. installed for companies, and although one must not enter into controversial questions, one cannot help wondering in passing why municipal undertakings apparently cost so much less to lay down.

Then there are electrical tramway or light railway undertakings, either completed or under construction, with a total of 1,628 miles of single track, with a capital outlay of approximately £16,000,000, and there are 720 miles of other light railways contemplating the adoption of electricity as the motive power.

I do not intend to bore you with further statistics, suffice it to say, that electricity is now slowly but surely superseding other illuminants, and as a power transmitter other less efficient methods; and already there are railways—if only short and special ones—to which centralised power generation is being applied to the exclusion of the steam locomotive. Among the future problems with which some of us will have to cope will, I believe, be included the electrical equipment of our great railways.

Recently there has been much energy displayed in obtaining powers to lay down immense generating stations from which electrical energy is to be transmitted over wide tracts of country. I am convinced that if this development be not carefully considered, it may be a serious matter for the whole industrial position of England. Several extensive power schemes have received the Royal assent. Where there are a number of small towns, each of which with, say, 10,000 or less inhabitants, and possibly the demand for a network of inter-connecting light railways, it would undoubtedly be a waste of public money to put down separate sets of plant for each little place. In such a case it is probably the most rational method to adopt a station common to them all. But where a town has a population of, say, 20,000 or more inhabitants, it deserves consideration whether it may not be cheaper and better to instal a local station, rather than take energy in bulk from a distant one, and then after transformation to distribute it locally. The all-important advantage claimed for these county stations is an improved load factor, but I fail to see how in the same latitude the summation of a number of small peaks is going to result in an improved load curve; and yet upon this factor all depends.

If it be not reached, then the reduced efficiency of a high-pressure system transforming its pressure locally, and in all probability also converting the current, together with the largely increased outlay on long primaries and sub-station machinery may be found to give less economic results than several smaller stations situated near the centres of demand, and distributing immediately into their networks without transformation. The outlay on local feeders and distributors will remain much the same in both cases.

The efficiency of a direct-current station (that is, the ratio of units sold to the units generated) rarely falls below 85 per cent., whereas a three-phrase 6,000-volt station, with an average length of primary of five miles, and sub-station transforming and converting plant cannot well be more than 68 per cent. In other words, 25 per cent. more units have to be generated in the second case than in the first. Should the load factor be improved 2 or 3 per cent, will not the less efficiency of, and the extra capital outlay on the big power station, more than counter-balance the advantage gained in the load factor? For some districts—as in Lancashire—where the mills are as thick as leaves in Vallambrosa, it will be the only known natural and economic means of driving them. But speaking generally, it will be worth while to carefully consider each case before large sums are launched into such an undertaking.

It is most important that electrical supply should be as reliable and continuous as that of water or of gas.

Improved means of storage seems to me to be a method by which a much improved load factor, less cost of production, and greater reliability of supply can be obtained. On this account, I have always felt that if a direct current system of distribution is at all possible in any district, it is wiser to adopt it to enable storage to be effected either now or at some future period. The cost of a storage battery may be taken (for a 7 hours' discharge) at £8 per KW., and the equivalent in boiler, engine, dynamo, and auxiliaries at £21 per KW. At the present time the life of batteries does not exceed 10 or 11 years, whereas the mean life of a generating plant may be taken at about 20 years. The capital charges on a storage battery, therefore, are practically twice as heavy per KW. as those on generating plant.

A surprising result will be found if one takes the trouble to prepare careful estimates of two stations, one fitted with generating plant only, and the other with only half of the plant installed in the first example, and the remainder absorbed in batteries. The capital cost per KW. is less in the second case; and might it not be well to go more carefully into this matter, and see whether we cannot adopt storage on a larger scale than now? And, too, the cost of output is really not so great with batteries, even after making due allowance for the loss of energy and the heavier rate of maintenance. Against the charges is to be put much increased output or plant load factor.

In traction systems of moderate size also the mean load is but one-third of the maximum, and here again I believe storage will play an important part in the future economical supply of electrical energy. I do not wish to be *doctrinaire*, but I cannot help feeling that this only will enable the cost of supply to be reduced to a minimum.

There is another question, viz., the influence of capital costs on cost of production, too often overlooked by some electrical engineers. One finds that graphically these represent an hyperbola. Their influence on units sold per kilowatt demanded is very great, and they bear an almost constant ratio after the first few years to the units sold, or, put in other words, the capital outlay increases *pari passu* with the units sold; therefore, this part of the total costs, after a time, is practically unvariable. This is important, and it is not difficult to ascertain what the minimum cost of production under the present conditions will be. Again, the other standing costs now are fairly proportionate to the total plant installed, once the station has grown to a fair size. So long as the ratio of day load to maximum demand remains as it is to-day, and we have to provide a maximum of running plant commensurate with the demand, will it be impossible to supply energy at so low a figure as some people hope for.

The "Brighton" system of charging is a brilliant attempt to meet this difficulty, and is, in my opinion, the most scientific method in vogue, but it is not without objections raised by consumers, and is often disliked by them when they get no rebate. Even in this case a round 24-hours' supply requires a 1½d. per unit to meet expenses, without profits, owing to the dominating influence of the capital charges.

What is likely to be the minimum cost to the bulk of consumers who only average three hours a day? Storage with less costly, more efficient, and longer lived plates than we have at present, would go far towards reducing the cost of supply, and averaging the cost to all classes of consumers.

I would like to say something to those engineers who may be called upon to design stations. Make your watchword and your guiding principle "simplicity."

Simplicity shows good design, means economy in first cost, and certainly economy of maintenance. But though simple, let everything be of the best, easily seen, and get-at-able, and as a station is, so should the mains be. Mains, which in all systems have their weaknesses, are out of sight, and, I am afraid, very often "out of mind," until an accident happens.

This brings me to another matter, which will require most careful thought in the future, viz., the large outlay on mains through which the maximum load is conveyed for only about one hour a day. If one could put a storage battery into every consumer's house, and supply at a uniform rate all the 24 hours round from the generating centre, letting the consumer draw off his supply at will, as to a certain extent is the case in the water supply of any house, the mains could be of a far less sectional area than they now have to be. To expect such a thing as this is, of course, nonsense; but, if in any given area one places the generating stations as near as possible to their load, the amount of copper required will be far less, of course, than when supplied from one station at the same pressure. It will be said if a high-pressure system is adopted, this is but a small item. Is it? Does not the saving in copper in a high-tension system have to be spent on insulation, transformers, sub-stations, and switchboards, and probably converters? The efficiency of distributors will always be low, from the fact that they have to be in every case of moderate potential, and must be of such a section as to cope with the maximum number of lamps connected thereto. They will improve, however, as the applications of electricity become more universal and varied.

A simple system of mains, good both mechanically and electrically, is what should be aimed at. Reliability of supply is most necessary. High voltage lamps are helping us greatly in reducing the outlay on mains, but even remembering that doubling the pressure on any main of a given section doubles the energy which may be transmitted thereby, and is quadrupled in a three-wire system, compared with a two-wire half-voltage system. I am revolutionary enough to believe that ultimately a plain two-wire system of distribution will be preferable to a three-wire distribution now so universally employed. The effect of the cost of insulation, and the comparatively large balancing wire required in practice (much larger than is demand in theory), levels the economy down that is said to be gained in a three-wire system enormously, and the effect on insulation of the negative cable, by putting a permanent stress upon it, and the effect of osmosis, caused by earthing the middle wire, does, I know from experience, cause a much heavier rate of depreciation on that cable and the negative service leads, which more than counterbalances the economy thought to be gained. Here again, perhaps, I make a fetish of simplicity, but is not good engineering building that which endures, and giving one's clients material which shall be lasting, and, at the same time, be the best procurable for the least money?

English engineering, if slow in progress, if conservative in policy, is at least recognised as being sound. We are members of a profession which will have an enormous influence on the commercial position of our country. It must be our constant endeavour to uphold the traditions of British engineers, and develop our industry on sound, broad-minded and progressive lines.

The fact that one of our members was accorded a special premium last year by the Council should give rise to a spirit of enterprise among us.

Electrical engineers as a body have a great work before them, which must be diligently carried out—our country will depend

much in the future competition with other nations, and struggle for existence upon the economical applications of electricity—for the moment it would seem that we are not keeping pace with our more enterprising cousins and neighbours, and that great schemes are passing into the hands of our competitors. If there is much inertia in the Briton—there is much momentum when he is once in motion. Let us take heart from this knowledge, and decide to contribute each one of us his share towards the national need and the continued advancement of the great art of engineering.

ELECTRICAL PROGRESS AND LEGISLATION: THE NEED OF REVISION.*

By R. PERCY SELLON, M.I.E.E., Chairman of the Electrical Trade Section of the London Chamber of Commerce.

I.

The progress of electrical science should be an object of peculiar interest alike to statesmen and the public at large; for the part that it is already playing, and is destined in far greater measure to perform, in the evolution of a healthier life for the community by the mitigation of the pressing evils of localised congestion of industries and overcrowding of population, must be apparent to any one who will take the trouble to master the facts. The air is so full of the lamentations of many trades threatened by the operation of economic laws consequent upon the great commercial awakening of other manufacturing countries, that the voice of those who point to the special claim of electrical science to benevolent treatment at the hands of the Legislature is liable to be lost in the general din, or to be regarded as the special pleading of men who are merely protesting against the seizure of their heritage by more capable hands.

In point of fact it is the nation at large, and not merely a few units comprising the electrical industry, which is essentially concerned in its growth or decay. For until some alternative agent is discovered, it is to electricity that we must look for the provision of a cheap and healthy artificial light; a cheap and ready motive power accessible whenever required without the necessity of going to a factory or crowded city to obtain it; a cheap means of transit between business centres, or between work and leisure; and a cheap and efficient means of communication with one's neighbours. It cannot be said that at present we do more than touch the fringe of these advantages. It is certain that with their full possession the physical and moral structure of society will be benefited to a degree which those who realise the intimate relation between health, poverty, and crime can readily appreciate.

Can it be said that we have as a nation taken advantage of the possibilities which electrical science has so far brought within our grasp? The reply is that we are both absolutely and relatively to other leading communities of the world in serious arrear of the position we should have attained, having regard to the commercial traditions, free institutions, and highly organised industrial equipment of which we were the heirs when, less than a quarter of a century ago, the great developments of electrical science in the fields of telephony, lighting, traction, and power distribution, passed from the purely experimental stage into practical potentialities.

No observant man who has travelled abroad or has studied the authentic facts and figures published at home can be in doubt as to the truth of the foregoing proposition. The evidence in support of it is so easily accessible to all, that I do not propose to labour the proof, but pass on from the effect to consider the causes.

I propose to prove that, so far as the electrical industry in Great Britain is concerned, the main cause must be traced to the statutory conditions under which it has been fostered, or rather, retarded.

II.

When the Paris Electrical Exhibition of 1881 forced upon the world the realisation that a new industrial era had dawned, by the almost simultaneous perfection for commercial purposes of the dynamo, the electric motor, the arc and incandescent electric light, and the telephone, all within the span of the last few years of the previous decade, there appeared to be good reasons to suppose that Great Britain would play the leading part in taking advantage of whatever of public benefit there might be in the phenomenon there presented. The researches of Faraday, Tyndall, Davy, and others, which had sowed the seeds of the subsequent growth, were household words to our inventors and electrical engineers. They had been followed by the brilliant inventions of Cooke and Wheatstone, Thomson and others in the domain of land and submarine telegraphy, which augured well for similar achievements by our electricians in other branches of electrical science. Our free trade, unparalleled manufacturing facilities, capital resources, and control of the cream of the world's markets, constituted cogent grounds for prophesying rapid progress and success against all comers. Yet the electrical industry has not thriven in our soil, while it has borne ample fruit in situations which appeared less promising in 1881.

It may be said that this is due to causes with which we are all now familiar, *e.g.*:—

(*a*) Reckless speculation and subsequent loss of public confidence in electrical undertakings.

(*b*) The unforeseen commercial expansion of America and Germany, which is cutting into our engineering trades generally, and therefore into electrical engineering among them.

(*c*) Unfavourable labour conditions at home.

(*d*) The apathy of our electrical engineers and manufacturers.

No doubt some or all of these causes have contributed in a measure to the result; but a little analysis will disclose the fact that they do not satisfy all the conditions of the problem.

Of the speculation in electric lighting enterprise which characterised the early eighties, it may be said that it was not confined to this country, and that it is a phase through which many other industries, notably railways, have passed, without in any permanent sense crippling them. No doubt the reaction from unjustifiable optimism on the part of the public, as to the instant future before electric lighting, brought about its inevitable penalty of subsequent loss of capital and confidence, and led to a period of pessimism towards all electrical enterprise which still persists in the face of the fact that foreign countries, chiefly the United States, are pouring capital into certain channels of electrical enterprise in Great Britain which experience has taught them to be profitable. This persistent pessimism points to the settled belief in the mind of the British public that the prevailing conditions by which electrical enterprise is hedged in do not offer sufficient prospective reward to the investor. There is failure to discriminate and to realise that the class of undertakings which are receiving the support of foreign capital are not subject to the conditions which have made electric lighting and tramway undertakings generally an object of suspicion to investors; and the circumstance that foreign capital is equally shy of the latter in this country, justifies and confirms the attitude of the home investor, and points to the fact that the main cause of our slow progress must be sought elsewhere than in the continued timidity of the home investor towards a class of investment in which he has formerly suffered loss. It is noteworthy that since the inception of electrical enterprise here other industries, such as cycle and automobile manufacture, have sprung up and passed through the speculative phase, but have nevertheless recovered and continued to attract capital for their development, because they are not retarded by the essential cause which has held and still holds the electrical industry in check.

The pressure of foreign competition is so much linked up with the subject of labour problems in this country, and the alleged unwillingness or inability of our engineers and manufacturers to learn of their foreign rivals, that these points may be considered together. It is unfortunately undeniable that both in America where wages are higher as well as in Germany where they are lower than in Great Britain, the productive coefficient of the average working man appears to compare favourably with our own. This is doubtless in part due to the higher standard of technical and commercial education which has in the past obtained abroad, and in part to the economic fallacies which dominate our working classes and lead them to adopt such heresies as the limitation of output and the levelling down of effort to the capacity of the weakest worker as being principles for which they must struggle and on which their advancement as a class depends.

It is equally undeniable that many employers of labour, lulled into false security by the industrial supremacy which this country achieved during the last century, have been slow to realise that new conditions have arisen which have modified the previous distribution of productive forces. America and Germany have been enabled, by a period of peace and wise statesmanship giving the commercial instincts of their people free play, to develop for the first time in their history territories and material resources as great, or greater than ours, and since they have been unhampered to the same extent by vested interests and conservative traditions, there is nothing remarkable in the fact that they no longer require to buy our goods, and can even undersell our manufactures at home and abroad in the products of those industries which they have specialised and organised to a higher degree than ourselves. But this does not sufficiently account for the slow growth of the electrical industry in Great Britain, because this is not primarily a manufacturer's question, but is apparent all along the line of electrical development, and is as marked in the domains of electricity supply and electric traction as in that of manufacture of machinery.

Much has been recently said of the failure of our engineers and manufacturers in the matter of standardisation of products, and the disadvantageous position in which they find themselves, compared with their foreign rivals, who, by standardising and specialising the character and details of their goods, can sell cheaply and deliver promptly. It must be frankly owned that this charge is to some extent well founded, and, so far as the manufacturing branch of the electrical industry is concerned, this explanation largely accounts for the fact of foreign-made electrical appliances being installed even in such strongholds of British industry as Manchester and Glasgow, where the municipal authorities have recently placed large contracts for electrical machinery abroad.

But while the British electrical manufacturer cannot escape this criticism, he can and does trace his misfortunes back to the cause which is the thesis of this paper, viz., that the policy which has dominated the Statutes affecting electrical progress and the action of the State thereunder, has forced the manufacturer into an *impasse* from which he would willingly free himself but cannot. The explanation of this will appear later; meantime in support of the contention it may be pointed out that where the British manufacturer has been left free to standardise his products he has been willing enough to do so, as, for example, in the hardware, agricultural machinery, steam and gas engine, cycle, and other trades. Moreover, the backwardness of electrical progress in Great Britain cannot be attributed to the methods of the British manufacturer because there is no obstacle in the nature of protective tariffs, &c., to prevent proprietors of electricity supply and traction undertakings from buying their requirements abroad, if the capital for such undertakings were forthcoming. Hence to argue that electrical progress in Great Britain is in arrear because the British electrical

* An address delivered before the London Chamber of Commerce, Wednesday, December 18th, 1901.

manufacturer is behind his rivals, is to reverse cause and effect, since the backward state of the electrical industry and of the electrical manufacturer are due to one and the same prime cause.

III.

What, then, is this prime cause?

The answer lies in the fact that the Legislature has applied to electrical science those principles of common ownership or collectivism which during the last half of the past century gradually established an increasing hold on men's minds in this country. The State ownership of telegraphs, its claim to all means of telegraphic communication by electricity, and its consequent attitude towards telephony and wireless telegraphy is one notable outcome of this attitude. The immense increase of rate-aided undertakings by municipal authorities, with the accompanying burden of local indebtedness, is another.

The increasing pressure of legislative detail which Parliament was called on to bear, the growth of the factory system consequent upon the introduction of steam, and the resultant activity of municipal life, led the Legislature in the early years of last century to gradually adopt a policy of decentralisation and devolution of sanitary and local burdens into the hands of local authorities. This policy found expression in the Municipal Corporation Act, 1833, and from this time onwards the principle of local self-government has been continuously fostered through the Public Health Acts, 1848 and 1875, the Local Government Act, 1858, and other measures.

Municipal corporations, who had in the past frequently wielded their powers with irresponsible disregard of the public interest, and had laid themselves open to constant charges of corruption and restraint of trade and industry, were, by the Act of 1833, restricted in their operations, and their functions placed on a modified footing. Their status became essentially that of trustees, and no longer owners, of the corporate property of their communities. On this foundation the Legislature has built up the superstructure of local self-government which has now attained to such remarkable proportions. Municipalisation, in the sense of rendering public service to communities in matters of protection of life and property; preservation of order; maintenance and improvement of highways; sanitation; provision of open spaces for recreation; education; burial; and such general needs common to all was freely encouraged, with benefits to the social welfare which none will deny. Water, as a prime necessity of life, and closely linked with sanitation, soon became recognised as a suitable object for municipalisation, and some 250 local authorities have received authorisation from Parliament to undertake supply of water to their ratepayers, the capital engaged amounting at the present time to some £50,000,000. Next gas, tramways, and a variety of other modes of provision for the living and disposal of the dead have come to be claimed as the legitimate sphere of municipal enterprise. Between the years 1840 and 1880 many large towns—Birmingham, Glasgow, Leeds, Liverpool, Manchester, and others—entered the debatable ground which divides municipalisation, the supply of common needs, from municipal trading, the provision of a commodity from the common purse for the benefit of a limited number, and frequently with a view to profit in aid of the rates or of introducing or supporting some other unprofitable venture. In the hands of able organisers (as Mr. J. Chamberlain, sometime Mayor of Birmingham), which the civic life of our great industrial cities attracts to the conduct of corporate affairs, these undertakings appeared to justify by results their departure from the original intention of the Legislature.

In 1870 the State bought out all the private telegraph interests in the country for £10,000,000, and set up as monopolists in the art of transmitting intelligence by electrical means, thus giving the highest sanction to the principle of common ownership *versus* private enterprise.

When, therefore, electric lighting and power emerged, during the decade ending 1880, from the laboratory stage to that of industrial potentiality, the mind of the Legislature was ripe for viewing their possible developments from the standpoint of collectivism; and under the guidance of Mr. J. Chamberlain, then President of the Board of Trade, gave expression to its convictions in the Electric Lighting Act, 1882.

When electric traction made its appearance a few years later, it found itself subject to the same influence in the shape of the Tramways Act, 1870.

The invention of the telephone in 1877 met with instant public recognition. But no sooner did the State realise in it a serious rival to its telegraph monopoly, than violent hands were laid upon the invention, and the subsequent policy pursued has left Great Britain the worst served country in the matter of telephony of any great industrial State.

Steadily the tide of municipal ownership has flowed on and encroached upon the functions of joint-stock enterprise and private trade. To-day the following trading undertakings have been inaugurated by local authorities, or powers to do so are being sought: bakeries, banking, building, coal merchants, colliery-owning, fire insurance, hotels, games, kursaals and refreshment rooms, theatres, supply and manufacture of electric fittings, and of residual products of gas, milk supply, pawnbroking, printing, steamboats, tailoring, telephones, &c.

It is needless to point out that many of the trades in this category are of a highly specialised and speculative character. Yet insignificant local authorities, with neither material nor intellectual equipment for such undertakings, are vieing with great corporations in an eager race to engage upon them with the funds of their ratepayers.

Study of the debates in Parliament at the time of the passing of the Tramways Act, 1870, and the subsequent Electric Lighting Act, 1882, shows that the Legislature was influenced at this epoch by the failure of earlier legislation relating to water, gas, and similar undertakings to provide for adequate control in the public interest. The favourable terms secured by the telegraph companies in consideration of the transfer of their property to the State also appear to have determined Parliament that in future legislative facilities afforded to promoters soliciting the right of user of public thoroughfares, or of otherwise performing public service, should in return secure to the community through the local authority an option of expropriating the enterprise in due course without a burdensome addition in respect of good-will and compensation for prospective profits. This principle found expression for the first time in the Tramways Act, 1870, immediately following upon the State purchase of the telegraph interests, and it has since become a settled maxim of industrial legislation, reappearing again and again in subsequent statutes, such as the Electric Lighting Acts, 1882 and 1888.

This action greatly accelerated the pace of municipal enterprise, as is evidenced by the fact that in the last quarter of the past century the local debt increased from some £90,000,000 to over £260,000,000, or nearly 200 per cent.; its ratio to the National Debt rose from 12 per cent. to nearly 45 per cent.; and while the population increased by less than 25 per cent., the increase in rates amounted to some 175 per cent.

Into the general aspect and public policy, however, of municipal trading it is not here proposed to enter. It is a question of profound national importance whether the alluring end of common ownership with all its promises may not be too dearly bought at the cost of the extinction, inevitable if gradual, of private enterprise; whether gigantic systems of local self-government with their accompaniment of petty officialdom controlling all matters of daily existence will make life better worth living for the majority than a social structure founded on greater liberty and reward of individual effort; whether this country's past industrial supremacy can be better maintained, in the light of the conditions of acute external competition which have arisen and are becoming yearly more severe, by increasingly transferring the mainsprings of its operation from individual to corporate activity; whether socio-industrial progress can be better achieved under the auspices of necessarily inelastic and inexpert organisations such as corporate bodies acting as trustees of others' funds, than by expert administration stimulated by the hope of personal gain.

To consider this question as a whole, a Joint Committee of the Houses of Parliament was appointed in the Session of 1900. Evidence has been taken, but so far no conclusion has been reached. The uncertainty as to the future policy of Parliament in regard to these matters is alike unfair to local authorities and to those engaged or prepared to engage in the many trading enterprises which are affected by the present tendency towards municipalisation; and it would appear highly desirable that the Committee should be reappointed and bring its labours to a conclusion.

(To be continued.)

THE PROFITABLE SALE OF ELECTRICITY.

"Owing, doubtless, to the youth of the electrical engineering industry, no definite rule has been established among municipalities as to how they should charge for electricity consumed in their street lamps and public buildings; whether, for instance, this should be done on the sound principle of having only one universal tariff, or should special tariffs be arranged for their own municipal consumption?" "Should a Corporation make all ratepayers pay a uniform profit on the cost of production of the electricity they individually consume, or charge a uniform price to everybody?" These are extracts from the Presidential address of the first ordinary general meeting in convention of the Municipal Electrical Association, held so long ago as 1896, and the speaker was Mr. Arthur Wright. At the same meeting he read a paper on the "Cost of Electricity Supply" which closed with the words "the fact that up to the present only the very fringe of street lighting has been touched by the electricity supply undertakings, appears to the author a sure sign that Dr. Hopkinson's conclusions have been hitherto ignored by most of the responsible managers, and to again direct and urge them to give their closest attention to them has been the author's object in writing this lengthy paper." A year or two afterwards Mr. Wright submitted a paper to the National Electric Light Association, of America, elaborating the same views, and now before the Institution of Electrical Engineers he has gone further and propounded for consideration and criticism what he believes is the basis of such a "universal tariff" as he hinted at some $5\frac{1}{2}$ years ago.

At the end of his present paper he gives the proposed tariff in two forms:—

First, a charge of x pence per unit for that part of the

consumption which is equivalent to the use of the consumer's demand, for n hours a year (or quarter, or month, as the case may be); and z pence for any further consumption in the said period.

x is taken as high as possible, and is preferably the maximum rate authorised in the order. z is reduced as low as possible consistent with the cost of giving supply.

Second, a yearly (or monthly) charge per lamp demanded, and a charge of z pence per unit for the energy consumed.

The elasticity of the system lies in a reduction of the hours, or fraction of hours, during which the initial price is charged—the rate itself remaining unaltered—and a diminished follow-on rate for the "further" consumption.

In these suggestions there is, of course, nothing new. Even the wording has become stereotyped, but the arguments used in support of this form of tariff possess the novelty that attaches to everything written in the light of recent experience. Turning to the first few pages of the paper, we find the opposites, which Mr. Wright afterwards shows do not tend toward profit-making, coupled with a low average price. Although spread over 12 heads, these reduce in principle to four:—

A fixed price. This may be made uniform and low, in the hope that a large demand will obviate the necessity for a sliding scale; but mere output will not equalise the profits from consumers having very different load factors. Large early closing consumers may be satisfied, but they may be hopelessly unprofitable as customers. Where a fixed price is charged for public lighting no attention is paid to the number of hours per annum the supply is used.

A fixed price with discount. This, again, ignores the load-factor element, and if based on the load factor of the lamps installed it discourages the use of any but constantly used lamps.

Optional rates (sliding scale or uniform price). Early-closing and low load-factor consumers are supplied at an unremunerative rate, consequently others are charged at an excessive rate and expansion is hindered.

Day and night rates (Kapp's principle). The use of lamps is discouraged during the time most people require light. But the Kapp system "can be made commercially correct provided it be associated with the encouragement afforded by a Hopkinson tariff to use the plant during lighting hours." Otherwise "the use of electricity is encouraged when few can make use of it, and it is discouraged when the majority want it, while the profitable three-hour consumer pays three times as much for lighting as does the unprofitable one-hour consumer, instead of the latter having to pay very nearly as much as the former.

If the tariff be not standardised when consumers number thousands, a muddle, or something like it, must result. Glasgow, St. Pancras, and other places seem to delight in offering as many different tariffs as they can to the public without any direct benefit to the supply works. The first portion of the paper is closed by an attempt to arrive at the reason for complexity—it cannot be due to apathy, or to over-prosperity, or to sound reasons of expediency, so there seems no alternative but to assume that the reason is to be found either in scepticism as to the soundness of the Hopkinson doctrines, in an incomplete grasp of them, or in fear of displeasing early-closing customers. For our part, we know that the last six words give the solution, and the agitations at Hanley and at Blackpool, the change some years ago at Liverpool, and the reductions in initial rates at Chester and other places, go to prove this beyond the shadow of a doubt. As Mr. Highfield stated in the discussion on the paper, and as we have pointed out more than once, the real and only obstacle to the "universal tariff" is the difficulty of making the average shopkeeper or small householder understand the operation of a demand scale, and the impossibility of convincing the commercially important, heavily-rated early-closing shop or store proprietor that a method of charging can be just and reasonable that lands him with a lighting bill much in excess of his former gas bill and proportionately heavier than his small and unassuming late-hour-keeping neighbour up a side street.

As we have said, the paper divides itself in three parts—the statement of what not to do, the reasons why, and finally, the proper thing to do. The second, and most important, must now be considered at such length as we can give it. Mr. Wright divides the cost of electrical energy into:—

(*a*) The cost of getting ready to supply, or "preparation costs." These are again sub-divided into:—

1. The "preliminary or formation expenses," being those incurred by the necessity of obtaining the initial capital to start the undertaking.

2. The "standing-by costs" for the provision and maintenance of plant and mains in a condition ready to supply and distribute energy.

3. The "service costs," including the maintenance of services and meters, and the incidental disbursements connected with accounts for supply, attending to complaints and collection of monies.

(*b*) The "production costs," or the actual expenditure of continuing to supply and distribute electrical energy. These vary with the amount of energy generated and distributed, and the unit of the "production costs" is defined as "the increment of expenditure incurred by making a given set of plant and mains supply an extra unit of electrical energy. This expenditure is made up of—

1. The inclusive cost of fuel.

First, that required to keep the generating sets running longer per day, and

Secondly, that consumed in producing and delivering the extra unit to the consumer.

2. The cost of the extra water and oil used.

3. The extra wages paid to shift staff.

4. The extra wear and tear of plant, or increase in repairs caused by the production of the extra unit.

We will for the present omit any description of the method Mr. Wright gives for the determination of these factors and confine ourselves to results, assuming, in the absence of critical refutation of this portion of the paper, that the method is sound and gives unimpeachable figures. The Brighton municipal electricity accounts for 1900, treated by Mr. Wright's method, show the following characteristics:—

	Production costs.	Preparation costs.	Service costs.	Total.
Gross	£9,315	£34,316	£3,476	£47,107
Per unit sold ...	0 6d	—	—	—
Per KW. demanded	—	£9 13s. 4d.	—	—

Roughly, the total figure for coal per unit sold was ¾d., and of this ¼d. was used in keeping the plant in a position to supply, and ½d. was used in actually generating the energy. The financial result is given in full in the paper, but we will extract only the salient points:—

Consumers caused or produced a

	Loss.	Profit.
To the number of	524	2,331
Preparation costs	£3,616	£30,700
Production costs	160	9,155
Service costs (less meter rentals) ...	1,836	—
Bad debts	172	—
	£5,784	£39,855
The revenue was	1,921	£44,225
Balance being loss	£3,863	—
Balance being profit...	—	£4,370

Therefore a profit of ...	£4,370
Less a loss of	3,863
Left a balance of profit of	£507

This clearly shows that a very real loss is incurred in selling electrical energy at less than the equivalent of the combined expenses of standing by and production. Put in another, and even more forcible way, the cost of producing and supplying double the quantity of electricity that was actually sold would only have increased the charges on the revenue account by 17½ per cent., while the output would have been increased by 100 per cent. At Nottingham the rates are 4d. for 400 hours' use of the maximum demand, and 2d. after. This results in the profitable three-hour consumer having to pay 12 per cent. more than his fair share of the charges, and the one-hour customer obtained his electrical energy at less than three-quarters what it actually cost. Comparing the two scales:—

Brighton, 7d. and 1d.			Nottingham, 4d. and 2d.		Hours of daily use of maximum demand.
Cost	Present tariff.	Correct tariff.	Cost.	Present tariff.	
7·00d.	7·00d.	7·00d.	5·25d.	4·00d.	1
3·80d.	4·00d.	3·84d.	2·90d.	3·00d.	2
2·76d.	3·00d.	2·81d.	2·08d.	2·66d.	3
2·20d.	2·50d.	2·29d.	1·68d.	2·50d.	4
1·88d.	2·20d.	1·98d.	1·44d.	2·46d.	5
1·66d.	2·00d.	1·77d.	1·29d.	2·33d.	6
1·50d.	1·85d.	1·63d.	1·18d.	2·28d.	7
1·40d.	1·74d.	1·51d.	1·09d.	2·25d.	8
1·30d.	1·66d.	1·43d.	1·02d.	2·22d.	9

Simplicity of charge and low average cost per unit cannot both be obtained by the same tariff. A uniform price to all classes involves a long-hour consumer paying for the loss made on the short-hour consumer, thus keeping the cost and charges to the majority of possible consumers unnecessarily high, and causes the business to be retarded, and the load factor of the undertakers to be lower than it otherwise would be. If discounts are given on a "quantity," then a short-hour consumer, with a high demand, may benefit more than a long-hour consumer with a small demand. For example, a 1,000-lamp one-hour customer at 4d. per unit may have to pay £400, and this may represent less than the actual cost of the service rendered, whereas a 10-lamp three-hour consumer, at the same rate, will yield a profit on his small bill of £12. Mr. Wright advances the contention that equity of tariff, with its consequent necessary concomitant of a lower average price, is much more essential to the rapid general adoption of electric lighting than mere uniformity of charge per unit. Although often stated as an excuse for the uniform price system, that it is necessary to take the bad with the good, he considers that no business consisting in the supply of one commodity need willingly carry out this happy-go-lucky policy, when it can be easily avoided by a little thought and trouble.

So much for the main theme of the paper. We will return to the subject and deal with the side issues raised, and the criticism to which the propositions so definitely stated were subjected.

CATAPHORESIS.

By W. S. HEDLEY, M.D.

The introduction of drugs into the body through the uninjured skin has been known and practised for more than half a century. It was in 1833 that Fabré Palaprat suggested the administration of potassium iodide by this means. In 1845 Napier read a paper before the Chemical Society, and after him Wiedemann, Freund, and Helmholtz, investigated the subject. These investigations had been led up to by the experiments of Reuss, who, in 1807, demonstrated the electrical transfer of liquids through a porous septum, and by Porret, who, in 1817, had shown* that when a galvanic current is conducted through the living, fresh, sarcous substance, the contents of the muscular fibre exhibit a streaming movement from the positive towards the negative pole (as in all fluids), so that the fibre swells at the negative pole. Similar phenomena have been described under many different names—"electric endosmose," "electro-vection," "anodal and cathodal diffusion," &c.

In 1873 Prof. Herman Munk published a paper† on the cataphoric changes of porous moist bodies and on the galvanic introduction of various fluids into an intact living organism. In 1884 Erb, Sewandowski, Boccalari and others introduced medicinal substances into the body through the unbroken skin by this means, and showed their presence in the urine and saliva. In 1866 Wagner proposed the introduction of cocaine by the galvanic current. Dr. Morton, of New York, in that year turned his attention to the subject, and has pursued it up to the present time. In 1889 Mr. Newman Laurence and Dr. Harries read a paper on cataphoric medication before the Society of Arts, and Dr. Cagney brought the same subject before the Harveian Society. In 1890, at the Berlin International Congress, Mr. Edison read a paper, in which he described the following experiment:—Two jars were arranged, one containing a 5 per cent. solution of lithium chloride, with the positive pole in it, the other, a solution of common salt, contained the negative pole. One hand was placed in each jar, and a current of 5 ma. was passed for two hours a day for 10 days; the urine collected showed the presence of lithium. In 1892 a discussion took place at a meeting of the American Electro-Therapeutic Association, and the subject was dealt with by Mr. Kennelly and others. Gärtner and Ehrman, by adding bichloride of mercury to an ordinary hydro-electric bath through which a current of 100 ma. was passing, claim to have obtained the specific effect of the drug. In 1894 Dr. Morton read a paper before the American Electro-Therapeutic Association on "Electric Medicamental Diffusion." In 1897 Fubini and Pierini, of Pisa, detailed much experimental work, proving, as they considered, that for the introduction of some substances into the body it is necessary to have one direction of the current, for the introduction of others the opposite direction. Thus the iodine of potassium iodide, the salicylic acid of sodium salicylate and of lithium salicyatè, penetrate the organism when the negative pole is in the aqueous solution of these salts. The strychnia of nitrate of strychnia, the atropine of sulphate of atropine, the cocaine of hydro-chlorate of cocaine, &c., pass into the body when the positive pole is in the aqueous solution of these salts. Meissner, on the other hand, arrives at the following conclusions:—(1) Cataphoresis will take place from the positive pole only; (2) the electrode liquid must be a better conductor than the liquid within the tissues; (3) the current must be reversed every five minutes (this is because the "secondary internal resistance," due to the drying up or "choking" at the anode, becomes so great that it prevents a continuation of the process); therefore (4) both electrodes must be moistened with the liquid to be introduced, and the current reversed at intervals.

The facts of electrolysis do not seem adequate to explain the phenomenon of cataphoresis. Cataphoresis, or the mechanical transference of substances by means of the current (and usually in the direction of the current), seems to be a property of the current coincident with electrolysis, but not dependent on electrolysis, excepting so far as the latter is necessary to secure the passage of a current. In other words, the current once established, allows the propulsion of *undissociated* molecules along with it.

From the medical standpoint, cataphoresis presents itself under three heads:—(1) The administration of medicinal substance by transference through the unbroken skin. (2) The streaming movement of the fluids of the tissues from one part to another under the directive action of a current, a phenomenon which must take place in every application of a continuous current to the body. (3) *Metallic Electrolysis.* This combines two processes; the first refers to the electrolytic action at the positive pole, the electrode when metallic and not of platinum being itself attacked, and an oxy-chloride of the metal being formed, which (secondly) is driven on into the tissues under the directive (cataphoric) influence of the current.

It is especially the first of these that concerns us at present. The administration of lithium, iodine, and the production of cocaine anæsthesia are matters of routine with those who practice therapeutic electricity. Therefore it was with some satisfaction (short lived, alas!) that the present writer turned to the perusal of an article (a reprint from the *Lancet* of August 10th) on "The electrolytic transmission of sulphur from the Harrogate sulphur water through a pig's skin, and its therapeutic value on the human subject under similar circumstances in eczema, gout, &c."

The writer states that he has now proved that in a bath of Harrogate sulphur water, through which a constant current is passing, nascent sulphur is driven through the patient's skin into the circulation. The following is his description of the experiment which "proves" this:—"The assistant bathman at the Royal Baths, Harrogate, had been able to drive sulphur through three folds of blotting paper by electricity. It suggested itself to my mind to try to do

* In "The Annals of Philosophy."
† "Archiv. für Anat. und Physiol.," 1873, Physiological Section.

the same through a pig's skin. A piece of pig's skin was tied round the mouth of an open-mouthed vessel, the bottom of which had been previously knocked out. A piece of blotting paper was placed outside the skin external to the vessel, and the positive end of an anode was placed on the blotting paper."

Now, what is the positive end of an anode?—The anode is the point of entrance of the current into the electrolyte.

The writer continues :—"The vessel was then filled from the bottom with Harrogate sulphur water and the negative anode was put into it." The electricity gets more and more "mixed";—What is a "negative anode?" If the anode is negative, what is the polarity of the cathode? The writer goes on to say that "three milliampères from a 13-celled battery (constant current) were turned on for half-an-hour." We need not stop to inquire what current other than a constant one might be expected to proceed from a 13-celled battery! The article continues :—"The result was that nascent sulphur was deposited on the pig's skin, driven right through it" (*i.e.*, against the direction of the current) "and into the blotting paper at the positive pole." The author, without giving further information as to the nature of the bath, whether monopolar or dipolar, the disposition of the electrodes, the strength and direction of the current, the duration of the immersion, &c., finally proceeds to ask :—"What is the therapeutic value of this discovery"? Interesting as it is, it may be prudent on the part of the reader, to defer the question of its therapeutics until his ideas have had time to settle and clear from the bewildering confusion of its electricity.

In the meantime, the experiment teaches one lesson—viz., that if any real advance is to made in this or kindred questions, they must at least be approached with an adequate equipment of electrical knowledge. The present writer lives in the pious belief that some competent expert, perhaps one of the many who read the pages of the Electrical Review, taking up this question of cataphoric transference at the point where Edison, Kennelly, Morton, Lord Armstrong and others have left it, may find himself in a position to further study its phenomena, and, perhaps, to announce its laws. It is a process that may be turned to account in other arts besides the art of medicine.

"CA' CANNY"-ISM—AND OTHER THINGS.

By FRANK BROADBENT, M.I.E.E.

Electrical engineers, who have had much experience with the trades' union workman, will find little or nothing new in the recent correspondence in the *Times* and other papers on the methods of the bricklaying unionists. The principle of "Ca' Canny," defined as "go easy," which, translated into the vernacular, means "work at half speed," is not confined to the bricklaying trade. Every engineering works' manager and foreman are familiar with it. A premium apprentice of the writer's acquaintance was once requested to "Ca' Canny" because he was winding armatures faster than any journeyman in the shop. His reply, in a Scotch brogue that would require a pretty sharp knife to cut, was more forcible than elegant. The principle is all right for the man who was born tired, but, to the born "hustler," it is worse than hard work. Many papers, in commenting upon this feature of what is called the "newer unionism," think there is a lot of humanity in the argument underlying the principle of "Ca' Canny," which some writers prefer to call "restricting the output." The argument is, that if one man works at half speed it gives another man a chance. So it may. Logically then, if he works "dead slow," or does no work at all, he will make room for two other men, and it only remains for everybody to do nothing at all to find work for each other!

There is absolutely nothing new in this idea; the fallacy has been shown over and over again, but still workmen believe in it.

The other principal point raised in the *Times* correspondence is the fine line of demarcation which trades union men try to draw between one class of work and another. Well, this is not peculiar to the plastering and bricklaying trades either.

The notion that it is a plasterer's job to set a 6-in. × 6-in. tile, and a bricklayer's to set a 9-in. × 9-in., is no worse than the fine distinctions that are drawn between carpenters' and joiners' work in the shipbuilding trade, nor between fitters' and plumbers' work. Here it is a question of the thickness of a bulkhead or the diameter of a pipe.

This has already been pointed out several times in the columns of this journal, more particularly in a recent article dealing with the "National Industrial Association."

The electrical contractor is only too painfully aware of these minute sub-divisions of labour, and the small army of men it is sometimes necessary to employ for a triflingly small job.

But is there not some danger of these ideas or principles finding their way into employers' associations?

Do we not hear of attempts to prevent a dynamo manufacturer from erecting the dynamos he has built, and the accessories manufacturer from fixing the fittings he has made?

Is not this what is aimed at in the recent correspondence in the Electrical Review, and are there not rumours that the Electrical Contractors' Association has *views* on the subject?

No doubt the advent of the small wiring contractor, who has risen from the ranks, is to some extent responsible for these heretical notions; he has not yet had time to shake himself loose from his old associations. It will, however, be a difficult and delicate matter for an employer of labour to condemn in his workmen, what he holds to be correct when applied to his relations with other employers. Once this principle is accepted in employers' circles, no employer could logically employ two men in different trades! Quite an impossible state of affairs. Instead of discussing a question of this sort, there is a more urgent one that might well occupy the attention of the Electrical Contractors' Association, and that is the question of wiring rules, or, to be more correct, wiring and supply rules. In a paper read last session before the Newcastle section of the I.E.E., the want of uniformity in this matter was emphasised by Mr. F. Broadbent, the only redeeming feature being that with the exceptions of Glasgow and Manchester, no other municipality had power to enfore its rules.

This will not long be the case if the many Bills now before Parliament are passed. The wiring contractor will then have enough to worry about, without such questions as whose trade it is to erect a dynamo or a switchboard.

It is not that rules are objected to, nor their rigid enforcement, if the rules are sensible and reasonable, but do let us have some sort of uniformity first.

REVIEWS.

Hand-book for the Electrical Laboratory and Testing Room. Vol. I. By J. A. Fleming, D.Sc., F.R.S. London: The *Electrician* Printing and Publishing Company, Limited. Price 12s. 6d.

The present volume is the first half of a treatise on electrical measurements, which promises to be one of the most complete and useful general hand-books we have yet seen. The author states that it is intended primarily for the electrical engineer, as distinguished from the physicist and telegraphist; but there is much in the first volume, which includes the less technical portion of the subject, to interest a wider circle than those actually engaged in an electrical test room or works.

The author is, in our opinion, to be congratulated on the judicious selection of his material, and on the fact that he has preferred to describe *thoroughly* certain methods of measurement, rather than bewilder the reader by attempting a comprehensive catalogue of good, bad, and indifferent in things electrical.

A large part of the present volume is taken up with a description of the most approved methods for the measurement of electrical resistance. These are entered into with great detail, and full particulars are given regarding the construction of the different types of resistance standards and the materials employed for them. We have been unable to

find in the book any definite statement of the author's views as to the relative advantages and disadvantages of the employment of manganin for secondary standards, and the higher class everyday work. It is singular that, up to now, no essential improvements have been made in the process of artificial "ageing" of the wire with a view to getting rid of the wholly erratic and troublesome changes which always occur during the first year after adjustment. The annealing process described—namely, a single heating in an air bath for five or ten hours—has been shown to be quite inadequate to ensure the kind of permanency needed even for the better class commercial work, and it does not seem to be generally known that the coils made at the Reichsanstalt of this material do not enter their official career in the records till they are a year old, when the time-anneal has had opportunity to play an important part along with the more rapid effect produced by a considerable rise of temperature.

In a letter on the subject the writer received during the last few days from a distinguished French engineer, who has had a large experience of manganin coils, this property of the material in requiring so long treatment to render it really permanent is pointed out as a great disadvantage from the point of view of the instrument maker, rendering it nearly impossible to deliver a resistance-box with manganin coils within a reasonable time. At least two of our own leading firms refuse to employ it for their best resistance boxes, although continuing its use for isolated standards and special purposes. It may here be pointed out that with the increased use of potentiometer methods, where the *ratio* and *not* the *absolute resistance* of large numbers of coils enters into the result, there is less necessity for all these to be made of a metal of zero temperature coefficient.

A disagreeable property shown by some specimens of manganin used by the writer, manifested itself in a small but perfectly well-marked "resistance hysteresis" on cooling from a higher temperature to a lower. After a coil had been taken through a temperature cycle of some 15° C., about three days were required for the material to assume its original resistance at the lowest temperature. This behaviour, if detected in a standard coil, would suffice to render it unsuitable for most better-class work.

A singular superstition seems to have arisen in England about the soldering of manganin. Dr. Fleming quotes a statement made at the Physical Society some three years ago, that to ensure permanence it must not be soldered with soft solder, but with some material not containing zinc. But silver solder, which is recommended, *does* contain zinc in considerable quantity, it being usually an alloy made from brass wire and standard silver. It seems to the writer that the explanation is to be found in one of Feussner's original papers, where it is stated that *tin* is to be guarded against, and that by some slip "Zinn" has been translated "Zinc." The book contains a fair number of tables of the constants most useful to electricians, among which appear some old friends. A table is quoted from the catalogue of a firm of wire makers giving the resistance per lb., &c. (*not* ohms per metre), of resistance wires of different gauges. The conscientious clerk who drew up that table, giving in some places eight significant figures, and then, lest he should be thought lacking in precision, headed it "approximate," ought to be given a bench in the National Physical Laboratory, where he should be set to carry out his ideas of measurement into practice. Tell it not in Gath—specimens of these wires have passed through the writer's hands, whose resistance differed more than 20 per cent. from that given in the table.

In the chapter on the specific resistance of metals a footnote appears regarding the work of Dr. Benoit, the present director of the Bureau International des Poids et Mésures, inferring that his work on temperature coefficients still ranked as among the best experiments on the subject. This work, however, unlike his classic research on the ohm done in conjunction with Mascart and de Nerville, was not carried out at the Bureau, but more than 28 years ago, when Benoit was a student at the Sorbonne, and it must be remembered when discussing his results that the value taken for the boiling point of at least one of the metals used by him as high temperature baths is probably in error about 80° C. It is probable that the weight attaching to Benoit's reputation in the foremost rank of modern metrology may have deterred others from repeating some of these experiments, and there are few branches nowadays where data are more meagre.

The table on page 323 would have been much more useful had complete formulæ been given for the temperature coefficients of the different materials. For instance, when one looks up the coefficient for mercury, what is required in nine cases out of ten is the value at *ordinary* temperature, which is not obtainable from the much less useful mean coefficient between 0° and 100° given on page 323, and only in a roundabout way from that on page 321, but can instantly be obtained from the formula

$$R_t = R_0 (1 + 0{\cdot}000888\,A + 0{\cdot}0000010\,A^2).$$

In the chapter dealing with galvanometers no data are given as to the sensitiveness of the different types. Potentiometers, on the contrary, are gone into in great detail, though the information is divided between the chapter on electrical equipment and that on the measurement of E.M.F.

Throughout the book there seems a reluctance on the part of Dr. Fleming to express his own opinion on many of the practical points, where it would have been exceptionally valuable, but we note with pleasure that he has taken the trouble to convert all the various older data to standard ohms and C.G.S. units.

The indexes might easily have been better and more comprehensive, and the references to original papers are, perhaps intentionally, to any short publication in the columns of the *Electrician* rather than to the original source. These are, however, minor defects in what is, on the whole, a good book, which should be very useful to those for whom it is intended.

J. A. H.

CORRESPONDENCE.

Tramway Junction at Sheffield.

Our attention has been called to an article in your "Electric Traction Supplement" of December 13th, in which you describe a junction recently laid in Sheffield.

Your writer is very much in error when he states that the "ordinary cast-steel points and crossings were a constant source of trouble." The quality of material was never in question, the entire trouble arising from the construction of the road, as proved by the recent extensive reconstruction of the track to suit the traffic requiremente.

The old conditions threw considerably more work upon the points and crossings than would otherwise have been the case, yet after two years' rough working there was still considerable life in the castings.

Askham Bros. and Wilson, Limited.
PHILIP W. ASKHAM.

Sheffield, *December 18th*, 1901.

Tramway Specification.

I, for one, read with interest the remarks of "R. R. R." in your issue of the 13th inst., anent the specification just published for the Reading tramways.

It almost seemed as though all the skill and professional ability in regard to electric tramways and their equipment, was the copyright of the engineers to this scheme, but really their specifications and statements have been commented on so unfavourably, that I have come to the conclusion it is hopeless to expect consistency from them even in matters of "comparatively elementary arithmetic." For instance, in a recent matter connected with the tramways, one of the engineers reported that the tender of an American firm, amounting to £6,300, was 30 per cent. higher than that of a British firm who only quoted £2,286.

S. S. S.

Decomposing Rubber from Germany.

As we have lately been victimised by German material, we feel as if we should like to relate our experiences for the benefit of the electrical world.

Some 18 months ago we purchased a quantity of "Para strip," for which we paid a good price. This strip has perished in the most extraordinary manner, as the enclosed sample will show you. It is perfectly evident to us, and must be to anybody with a knowledge of rubber, that this so-called "Para strip" is mainly composed of oil substitutes.

We naturally remonstrated with the sellers, who are a German firm with a large business connection in this country. In reply to our complaint we received a letter, of which we enclose a copy, suppressing the names of the principals.

This throws such a flood of light on German methods of business and German material, that we think it might act as a danger signal to intending purchasers of German goods, including, perhaps, a large and wealthy Corporation.

Victimised.

Warrington, *December 20th*, 1901.

The following is the translation of the reply :—

Re claim for Para rubber supplied to ——

Replying to your esteemed favours of the 7th, 8th, and 14th inst., we beg to ask you kindly to excuse our not having replied to same before to-day; the delay has been occasioned by the absence of ——

We now beg to inform you that we cannot admit your claim. We have supplied to you the rubber of exactly the same quality as the sample which we had sent you, *i.e.*, a rubber strip vulcanised by the cold process. We could, of course, only presume that you were acquainted with the nature of an article produced in this manner; and had you possessed this knowledge, you would have known that this rubber is not of a very durable quality, but decomposes after some time, especially if it is not carefully protected against air and light. We presumed that you use these strips for the manufacture of rubber cables, in which the rubber, through the covering with cotton and compounding, is almost closed in air tight, thus used the rubber generally last for years, so that this quality has been used during the last 20 years in Germany on a very large scale, and is still being used in Germany as well as in England. Anybody, however, who buys this rubber, is aware of its not being a very good article, and it is, as a rule, only bought because the competition on the electrical market compels cables to be made at low prices.

We very much regret that you have apparently bought the rubber without knowing its qualities, and must decline any responsibility therefor, the more so as we never assumed the guarantee that the rubber would last 18 months.

Before you bring an action against us, we should suggest your consulting an expert in this matter, for we are perfectly convinced that you would lose the action.

LEGAL.

Metallurgical Engineering Company, Limited, and Another, *v.* the English Electro-Metallurgical Company, Limited.

The hearing of the action brought by the Metallurgical Engineering Company, Limited, and Another, *v.* the English Electro-Metallurgical Company, Limited, and Mr. John Oliver Surtees Elmore against the English Electro-Metallurgical Company, Limited, was continued before Mr. Justice Wright in the King's Bench Division of the High Court of Justice on the 19th inst. The action, which was partly heard on November 21st and 22nd, was reported in the Electrical Review for November 29th.

Mr. English Harrison, K.C., and Mr. Brooke Little were counsel for plaintiff company, and Mr. Macaskie, K.C., and Mr. Muir Mackenzie for the defendants.

On the case being called on last week a long consultation took place between counsel and the parties, after which

Mr. English Harrison said: I am glad to say the matter has been settled. The record will be withdrawn on terms endorsed on our briefs, and, therefore, we need not trouble your Lordship further.

Calendar.—A very handsome pocket-book has been issued by the Simplex Steel Conduit Company, Limited, of Birmingham and London. It contains a calendar, an engagement diary, a large diary, a place for memoranda, and also for addresses, cash entries, &c. It is also furnished with many pockets, and with a table of sizes of conduits, &c., on the "Simplex" system, and one likewise showing maximum number and size of conductors which can be threaded through the said conduits.

BUSINESS NOTES.

Bankruptcy Proceedings.—The public examination was held on Wednesday last week at the London Bankruptcy Court before Mr. Registrar Gifford, of Thomas Crisp Collingwood, who was allowed to pass upon accounts showing total liabilities £33,693 and a deficiency of £848 15s. 7d. In the course of his evidence the debtor stated that he had carried on several licensed houses, to losses in connection with which his failure was attributed. In or about 1891 he entered into partnership with a manufacturer of electric wire, trading at Clerkenwell Green, and put £2,000 capital into the business. A year later he withdrew, his partner agreeing to pay him £500, but only £200 had been paid.

Messrs. Johnstone, Benjamin & Co., Limited, have written to us as follows:—

Our attention has been called to a report in yours of November 29th last, in respect of the bankruptcy proceedings against Messrs. Lewis & Ernest Benjamin, from whom we, in December, 1900, acquired the business formerly known, and carried on by them, under the title of Johnstone, Benjamin & Co., and which has since been carried on by us. The report of such proceedings should have stated that reference was made to Messrs. L. & E. Benjamin, and had no reference to the Limited Company now carrying on the business.

Liquidation. — The Coley Electric Works, Limited, of 4, King Street, Cheapside, E.C., is winding up, with Mr. S. W. Oakley as liquidator.

Book Received.—"A Memorandum on the Mond Gas Scheme," by F. N. Keen. London: Walter King. 1901. 1s.

British Fire Prevention Committee's Tests.—We understand that among other tests to be expected early next year are tests by the Electric Timber Seasoning Company with treated wood, and by the British Uralite Company with fire-resisting slabs.

Catalogues, &c.—We have been favoured as usual with one of those very serviceable blotting pads and diaries of the Electrical Power Storage Company. The E.P.S. pads have served us well for many years past, and we believe that in a large number of electrical engineers' offices they are greatly appreciated. An accompanying sheet draws special attention to their latest types of cells, I.P. type for power stations, and the W.S. type for small lighting plants.

Messrs. W. F. Stanley & Co., Limited, of Great Turnstile, W.C., have sent us a copy of their net price list of surveying and drawing instruments.

The Commercial Cable Company's wall calendar for 1902 is a very pleasing production. The design is the work of a master hand, and the colouring is tastefully executed.

We have received from Messrs. Penrose & Co. a most profusely illustrated catalogue of all things appertaining to photo-engraving, for which a stock is held by them. The list also includes electrical switches, lamps, motors, &c., for engravers' use. It is beautifully printed on good stout paper, and will make a useful addition to any engraver's reference library.

The Union Electric Company, Limited, of 151, Queen Victoria Street, send us a new list of their 8-pole dynamos and motors of 75 to 405 kw. A special feature of this catalogue is the fact that each machine is so designed that it can be supplied at from five to seven different speeds without change of price, and can be made with or without one bearing, two bearings, bed plate, half coupling, or pulley. The dimensions and prices of the machines are included.

We have received a copy of the new catalogue (Section E) of the General Electric Company (1900), Limited. All the company's recent leaflets relating to arc lamps and accessories are here embodied together. The Angold open and enclosed arc lamps, and the accessories especially in connection with alternating current arc lamps, are described. We observe that the company is prepared to supply complete electrical theatre equipments. Electric fans and motor rheostats are also detailed. Among many other things of interest are the automatic lift controllers, which make it possible to completely dispense with anything in the nature of a hand rheostat. The rest of the catalogue is chiefly made up of Crocker-Wheeler plant, the agency for which the G.E. Company holds for customers who prefer the American type of machine. There is also other matter in connection with general engineering and complete plants. Section H, electrical heating catalogue, and Section P, dealing with G.E. Company continuous, and polyphase machines are shortly to be issued.

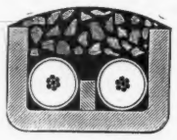
Howard Asphalt Conduits and Troughing.—The asphalt conduit and troughing manufactured by the Howard Conduit Company, Limited, of Trafford Park, Manchester, claims to obviate many of the disadvantages of the older systems.

Asphalt is claimed to be particularly suitable for pipes or conduits; it is impervious to water and air, resists fire and acids, is an electrical insulator, repels vermin, it is durable and easily repaired, and so ductile that it will yield to any ordinary pressure without cracking. It is unaffected by frost, and though softened by heat at about 125° F., does not disintegrate even at 350° F., and upon returning to its normal temperature has lost none of its qualities. The difficulties in manufacture have hitherto prevented the use of this material for pipes, as it does not become fluid with heat, but only acquires a pasty consistency, and will not readily flow into moulds. It also requires pressure to make it cool into a solid mass. The process of manufacture consists in placing the hot asphalt in a mould or sheet-iron pipe and revolving it rapidly. Under the influence of centrifugal force the asphalt spreads out into a cylinder of uniform thickness and is compressed into a solid mass. The heavier constituents are left on the outside of the pipe, forming a strong outer skin, and the lighter matter forms a smooth inner sur-

face. The pressure developed by centrifugal force is considerable, thus, a 3-in. pipe, revolving at 500 revolutions per minute, subjects every pound of asphalt to a pressure of 10·6 lbs., and the result is a solid pipe with a smooth inner surface. Pipes formed of asphalt only, if subjected to unequal pressures in various parts, might alter their shape. In order to prevent this a spiral of galvanised iron wire, or a covering of sheet-iron, is combined with the asphalt so as to maintain its shape. The coil of wire is embedded in the material, and is consequently thoroughly protected against oxidation.

Asphalt pipes are claimed to be especially suitable for conduits for electric cables, as the material is an insulator, and so prevents an earth contact if the insulation of the cable fails. There will also

Semi-Circular Troughing with Asphalt Cover.

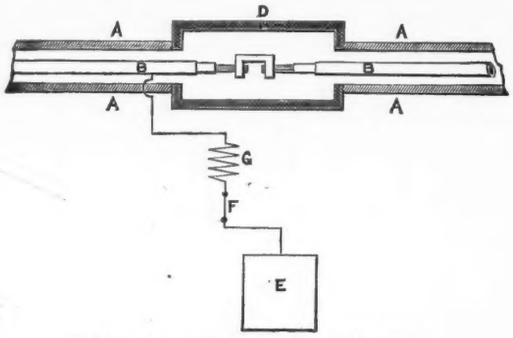


Square Troughing with Asphalt Cover.

Conduit.

be no trouble from electrolysis, which eats away the lead covering of the cables. The inner surface is smooth, and allows cable to be drawn through with a minimum of friction, and the joints between successive lengths are of the same size as the pipes themselves, so that a number of conduits can be run in the same trench, occupying the smallest possible space.

The labour in making joints is very slight. A cast-iron block of suitable shape is heated in a portable fire and applied between the two ends to be jointed. As soon as the asphalt is sufficiently warmed, the two ends are pressed together firmly and left to



Method of Earthing Lead Sheath.

cool, and a thoroughly-welded joint is made of the same strength as any other part of the conduit or trough; an expanding mandrel is inserted (in the case of conduits) to prevent any projection on the inside. The entire process takes about two minutes, and no skilled labour is required.

The troughing for use on the solid system is made on the same principle as the conduits, but without the spiral, and pressed into a rectangular shape. The cable is laid direct in the bottom of the trough without supporting clips, as these are rendered unnecessary by the insulating properties of the asphalt. This method of laying saves the large amount of bitumen compound necessary to fill in the insulating space in a cast-iron or earthenware trough, and also lessens the size of trough, and consequent excavation. A small quantity of melted bitumen is then poured into the trough only just sufficient to cover the cables. The remaining space is filled in with asphalt rock, which can be arched, as shown in the drawing, thus forming a solid cover, efficiently protecting the cable from external damage. By this method of laying, the cable is so thoroughly insulated from earth, that it is possible to use this protection as a safeguard against breakdowns in case of a failure of the insulation of the cables. The arrangement for effecting this purpose is as follows (see diagram above):—

An iron joint box, D, lined with asphalt, is used for connecting two lengths of lead-covered cable, B, laid in the asphalt trough, A; the lead of the cable is insulated from the joint box by the asphalt, and is connected to earth, E, through a resistance, G, and a fuse, F. The lead of the cable is divided up into sections by the method of laying. The only path to earth is through the resistance, G, and fuse, F. In case of a failure of the cable causing a short circuit to the lead and so to earth, in the ordinary case the cable is burnt out, or the circuit breakers opened, causing considerable trouble, especially in tram circuits. In this system of laying, the fuse, F, in the section in which the fault occurs is blown and the lead covering is then insulated from earth by the asphalt troughing. The cable can still be utilised until a convenient time for repairing the fault, and the position of the fault is easily found by an inspection of the fuses in the various street boxes without the necessity of making tests or interrupting the supply. The resistance G, is intended to prevent the flow of any electrolytic currents in sufficient strength to injure the lead. The flexibility possessed by asphalt is an important point in the system, as any ordinary subsidence of the ground will not cause a fracture, but will leave the conduit or trough intact, where an earthenware or iron trough would be broken.

The New Electrical Wiremen's Association.—A meeting was held at Westminster on Tuesday evening for the purpose of opening a central branch. A number of qualified men were enrolled as members. A long discussion was carried on with reference to candidates who were nominated for election, and who were not considered sufficiently experienced to be admitted as thoroughly competent wiremen. The chief aim of the Society is to protect the practical man and the electrical industry generally from the encroachments of inferior and cheap labour. Meetings will be held at the Pineapple, Wilfred Street, Westminster, every Tuesday at 7.30 p.m., and at the Alma, Parson's Green Lane, Fulham, every Saturday, at 8 p.m., until further notice, Christmas week excepted.

Trade Announcements.—Messrs. Gilchrist & Co., whose temporary offices are at 40, South King Street, Manchester, have been appointed sole agents for Lancashire and Cheshire for the Electric Lighting Boards (British Manufacturing Company, Limited). Messrs. Gilchrist are opening large showrooms at Great Northern Buildings, Deansgate, Manchester, where the different uses and designs of the E.L.B. system will be on exhibition. They will also hold large stocks of all the different electrical accessories.

We are asked to state that Mr. Simpson, of Hampton, has transferred his business to the Grant's Drill and Trolley Company, Limited, Ince, near Wigan. Works have been started at Ince by the company, fitted with special machinery for the manufacture of overhead trolley fittings and electric rock drills.

Tuckett v. The Isle of Thanet Electric Tramways and Lighting Company, Limited. — In the King's Bench Division of the High Court of Justice, last week, before Mr. Justice Jelf, this was an action by the plaintiff claiming £70 7s. as money due to him for work done at the request of the defendants, and as money due by virtue of the provisions of the Light Railways Act, 1896, and the Arbitration Act, 1889. Alternatively the plaintiff claimed damages for breach of contract. It appeared from the statement of claim that the defendant company were authorised to construct certain light railways in the Isle of Thanet, and for that purpose to take certain lands. The land authorised to be taken included that of a Mr. Beach, to whom notice to treat was given. Afterwards differences arose between the defendant company and Beach as to the amount of compensation to be paid to the latter for his interest in the land, and the parties failing to concur in the appointment of a single arbitrator, the defendant company applied to the Board of Trade to appoint one, and the Board of Trade nominated the plaintiff as arbitrator. The plaintiff undertook the reference, and viewed the land, and, by appointment with the parties, held a sitting at the Surveyors' Institution, at Westminster, on December 14th, 1899. In the course of the sitting the parties came to terms, and agreed between themselves the amount of compensation to be paid, and the defendant company, through their counsel, exonerated and discharged the plaintiff from the duty of making an award in the premises, and expressly undertook and promised that the plaintiff's proper charges for the reference should be paid by the defendant company. The solicitors for the plaintiff requested payment of £10 10s., as such charges, but the defendant had refused or neglected to pay. The plaintiff make a similar claim in respect of the land of I. A. & W. Tharp, in which case, however, he made an award, part of which was that the defendant company should pay the costs of the award, which were assessed at £59 17s. The award was not taken up by the defendant company, who entered into an agreement with Messrs. Tharp (who were also plaintiffs), whereby they agreed *inter alia* to purchase the lands in question at a stated price, and bear the arbitrator's costs, charges and expenses of the arbitration whether completed or not, and, if necessary, to take up any award and pay all fees.

The defence was that the defendant company never undertook to pay the plaintiff's charges except so far as they were reasonable, and that the charges made were excessive and exorbitant.

Mr. Danckwerts, K.C., and Mr. Cagney (instructed by Messrs. Waterhouse & Company), appeared for the plaintiff, and Mr. Bower (instructed by Messrs. William Webb & Company), was counsel for the defendant.

Mr. Justice Jelf was satisfied that in the case of Beach there was a direct undertaking on the part of the company that a proper fee should be paid to the plaintiff for his services. That was a contract for good consideration, and £10 10s. 0d. did not seem to him to be at all an unreasonable amount. As to the second case, he was satisfied the company were bound to pay the plaintiff's fees when the amount was properly arrived at. He had to decide what was the reasonable sum which ought to be allowed to the plaintiff in place of the £59 17s. 0d., and he assessed that amount at £45.

Judgment was entered for the plaintiff accordingly for £10 10s.0d. in Beach's case, and £45 in the case of Messrs. Tharp, making £55 10s. 0d. altogether.

U.S. Carbon Tariffs.—The U.S. Customs authorities have lately given a decision to the effect that round sticks of carbon, one-half to five-eighths of an inch in diameter, and from 12½ to 20 in. in length, being ultimately intended for, and exclusively used in, electric lighting, are dutiable as carbons for electric lighting under paragraph 98 of the Tariff, at the rate of 90 cents. per hundred.

MACHINE TOOLS AT THE GLASGOW EXHIBITION.

(In Special Reference to the Requirements of Dynamo and Motor Manufacturers.)

By FRED. BATHURST, A.M.I.E.E.

(*Continued from page* 891.)

The general arrangement of the stands in the Machinery Hall was such that it was very difficult to secure good photographs of the individual stands, but inasmuch as the exhibit of Messrs. Alfred Herbert Company, Limited, was one of the largest shows made, we reproduce fig. 11 from the best photograph that could be taken under the difficult conditions obtaining.

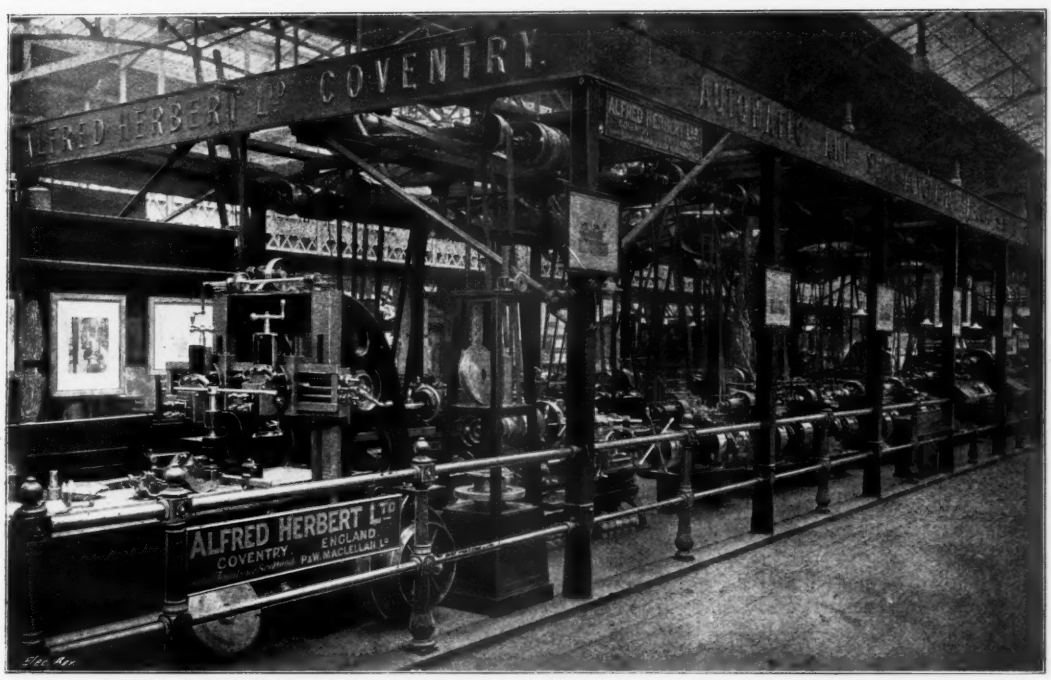


Fig. 11.—Messrs. Alfred Herbert's Stand at the Glasgow Exhibition, 1901.

Grinding Machines.

Messrs. Burton, Griffiths & Co., of Ludgate Square, Ludgate Hill, E.C., make a speciality of grinding machines, and the Landis machine (illustrated in figs. 12 and 13) is probably one of the best designed machines of the kind exhibited. The makers claim that the grinding machine is rapidly becoming recognised as an indispensable tool in all modern machine shop practice.

Its introduction has permitted the use of hardened spindles in lathes, milling and drilling machines, as well as crank and crosshead pins in steam engines, the value of which engineers will fully recognise. The Landis universal grinding machine is suited for finishing all straight, taper, conical and plane face surfaces, for grinding out holes, &c., in hard or soft steel, and, in fact, any kind of material.

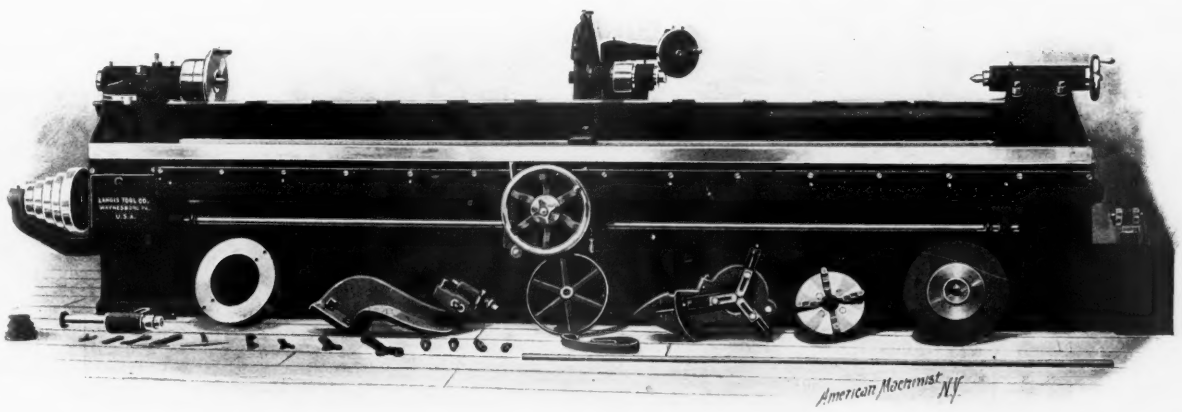


Fig. 12.—Landis Grinding Machine for Finishing Shaft Spindles.

Special attachments are provided so that other operations, such as the grinding of reamers, cutters, and saws, either the teeth or sides of same, can be readily performed. Any parts revolving on dead centres can be ground straight or taper within the capacity of the particular machine in use. It is

maintained that it costs less to finish and fit parts by the use of the grinding machine, than with a lathe, the latter tool being certainly handicapped in the case of particularly hard stock.

By finishing spindle parts on a grinding machine, perfectly cylindrical and straight shafts are secured, which will take less power to operate them, and will therefore wear longer. The most recently designed grinding machines are able to remove as much as $\frac{1}{32}$ in. of material by grinding, in less time than a rough cut can be made on a lathe, and the finish made on a grinder is finer; the common practice is now to rough out parts on a lathe, allowing ·005 in. to ·01 in. (dependent upon the character of the work), and then to finish off on a grinding machine.

The large machine illustrated, a No. 9 size, can be adjusted to feed $\frac{1}{8}$ of 1,000th in. on each reversal point, thus reducing the work $\frac{1}{4}$ of 1,000th in., or the feed can be increased to reduce work $\frac{1}{500}$th in. in diameter at each reversal. Such an automatic feed attachment of the emery wheel is useful for sizing work automatically, so that one operator can attend to a number of machines, all full of work at the same time.

These grinding machines are made to swing work from 10 to 20 in. diameter, taking same between centres 20 in. to 144 in. apart. The prices of such machines vary from £110 up to £500.

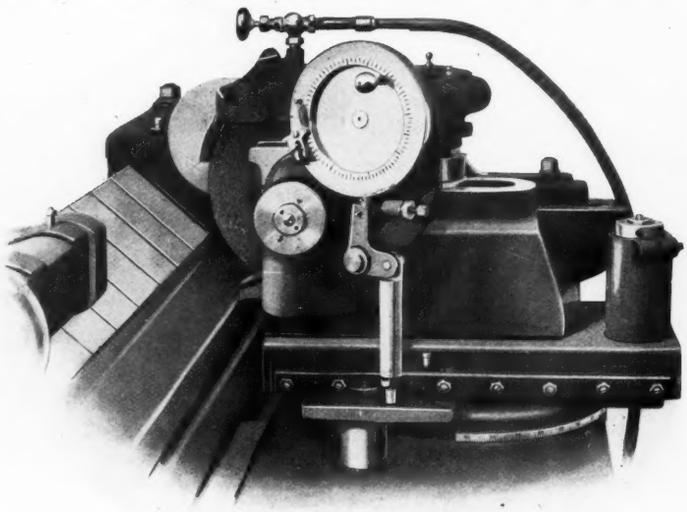


Fig. 13.—Side View of Landis Grinding Machine.

The same firm (Burton, Griffiths & Co.) exhibited a Roberts disc grinder (see fig. 14), which is a very useful tool for engineers, tool makers, and electrical manufacturing firms who may require to grind flat surfaces, for the finishing of rough castings, &c., which has heretofore been done by manual labour and a file. It is claimed that these grinding machines can turn out articles at least five times as fast as when they are trimmed up by a file. The machine is furnished with two tables, one of which is set perfectly square with the face of the grinding disc, the other being arranged to easily swivel for angular cuts up to 45° each way.

It is obvious that unskilled labour can thus grind surfaces exactly at any angle to each other that may be desired—work which an experienced workman cannot always effect with a file. Instead of using solid emery or other cutting wheels, ordinary sheets of emery paper or cloth are used instead. A higher rate of cutting speed than is possible with a solid emery wheel can thus be safely obtained. These emery sheets can be readily removed or exchanged without disturbing the tables, and provision is made for holding the spindle stationary, whilst the operation is performed.

A press (shown in the illustration at the side of the machine) is supplied, so that by using a suitable adhesive compound it is a simple matter to fasten an emery cloth on to the side of the steel disc, and leave the cutting surface

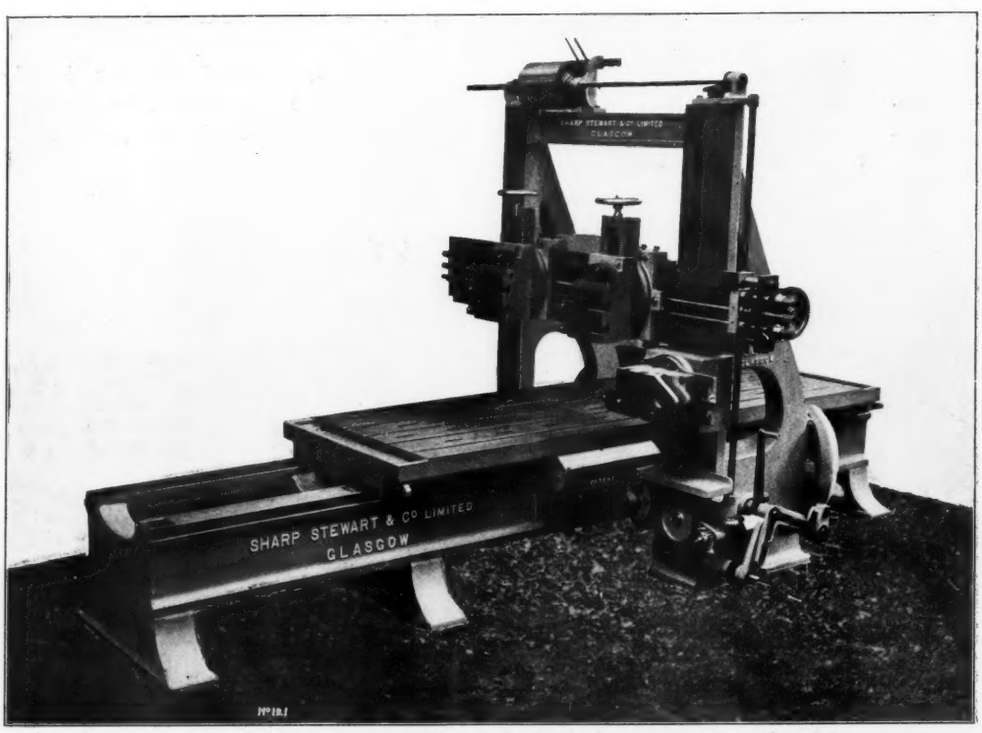


Fig. 15.—An Up-to-Date Planing Machine.

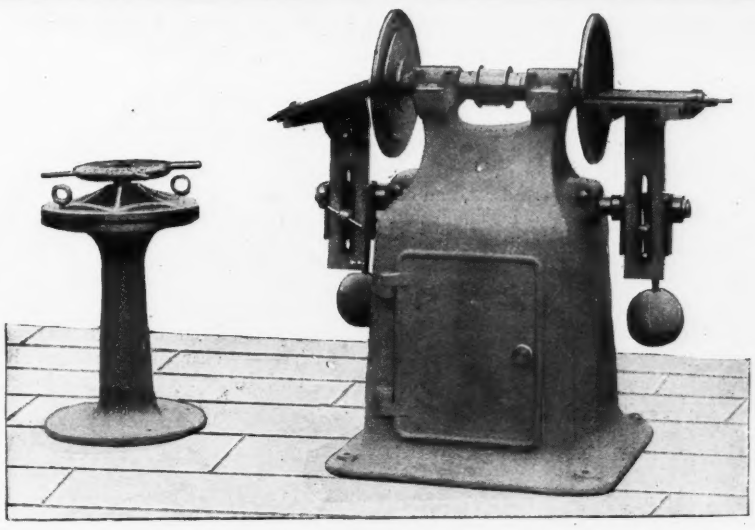


Fig. 14.—Emery Paper Disc Grinder for Rough Castings, &c.

perfectly true and even. Compared with ordinary emery wheels, this machine is said to have twice the cutting capacity, and whilst being quite safe in operation, is economical in first cost. A 16-in. machine with press and stand, complete with the necessary countershaft and spanners, costs £50.

Planing Machines.

Messrs. Sharp, Stewart & Co., Ltd., the well-known machine tool makers, of Glasgow, who have London offices at 28, Victoria Street, S.W., had an important and representative exhibit, and we illustrate their planing and slotting machines as being perhaps the most up-to-date machines of their particular types.

The planing machine (as shown in fig. 15) will plane work 4 ft. wide × 6 ft. long, taking pieces 4 ft. high. This machine combines the advantages both of the screw and rack-driving types, the bedplate being driven by means of a spiral pinion acting upon the machine cut rack, the worm running constantly in an oil well.

The driving motion is of a very complete character, the belt guides being adjustable mechanically so as to run with the belt on any angle; in reversing, one belt is quite clear of the fast pulley before the other belt moves on to it, so that the wear and tear of the belts is greatly reduced.

The returning speed is more than three to four times that of cutting, according to the nature of the work to be done; even higher rates of return speed can be provided for special classes of work. The bed and table have flat bearing surfaces, with special adjusting strips by which any wear can be taken up, and are provided with automatic lubricating devices.

The cross slide is in box section, specially designed to resist the pressure of the cutting. It can be raised or lowered by hand with double screws and suitable gearing. In the largest type of machine manufactured by this firm, the cross slide is raised by power.

The Robinson & Oldfield patent feed motion employed with this machine allows an automatic feed from $\frac{1}{16}$ in. up to $1\frac{1}{2}$ in. wide, and whilst being very easily adjustable, can be used horizontally to the right or to the left, and vertically or angularly either up or down. The feed is always put on at the end of the return stroke, so there is no strong pull over the work during feeding. These machines are said to have a greater productive capacity than any others in the trade.

The self-acting slotting machines also exhibited by this firm, and shown in our illustration (fig. 16), are designed with exceptionally massive proportions, and are specially adapted for heavy work. They are arranged to have a variable and adjustable stroke with quick return motion, and the ram is counterbalanced.

The main frame is designed as a box section, and gives a continuous bearing to the front of the ram. Two tools can be used at once, either side by side, or one above the other. The circular work-table has both hand and self-acting motions by worm and worm-wheel. The wear of all working parts can be taken up as necessary. In the larger sizes the work-

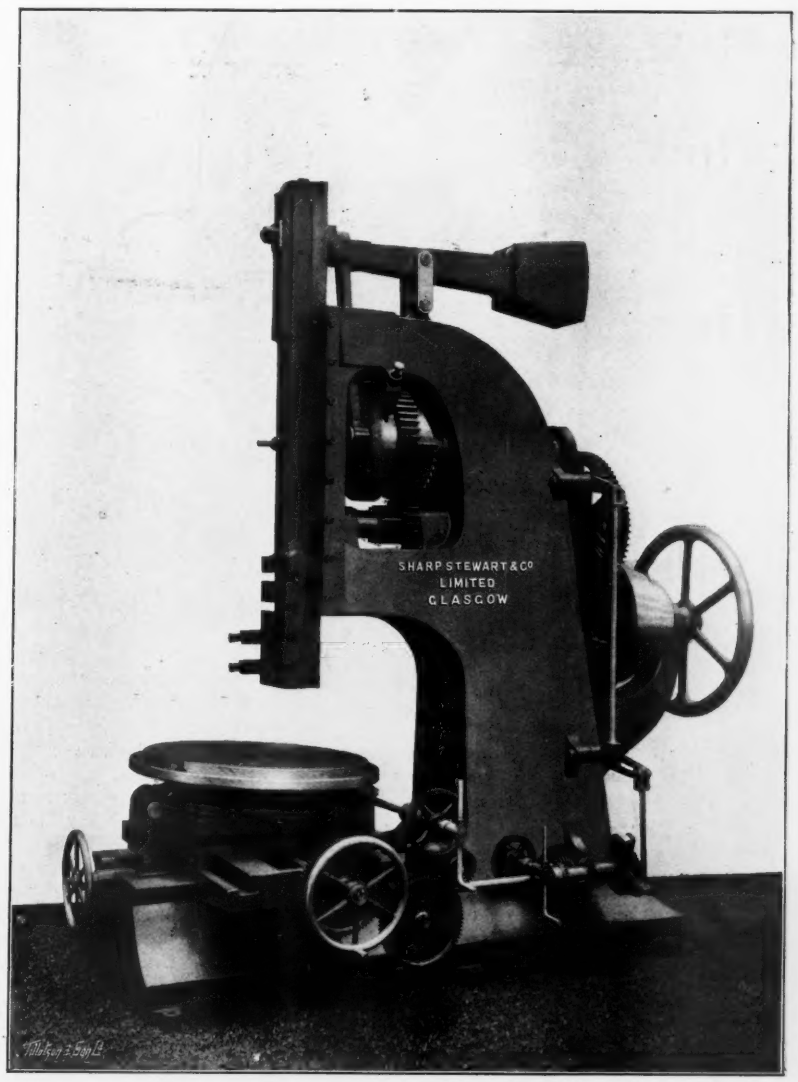


Fig. 16.—Sharp, Stewart & Co.'s Slotting Machine.

table is provided with power motion, so that it can be quickly adjusted. Canting tables for angular work can be fitted, for those shops likely to require them.

The machine illustrated has a maximum stroke of 16 in. The traverse of the top slide is 36 in., and that of the bottom slide 30 in. The diameter of the table is 3 ft. 6 in., and the distance of the tool-head from it is 3 ft., so that work 30 in. high can be taken on the table.

(To be continued.)

SOME TESTS OF THE REAVELL ENGINE.

The struggle for increased engine efficiency among steam engine manufacturers is becoming keener and keener as time goes on, and other means of power production make their appearance and threaten to compete seriously with the steam engine. Mr. Peter Willans was the first engineer who worked out a satisfactory design of high-speed engine, and his untimely death at an early age was a loss to the engineering profession which can never be fully recompensed. Mr. Willans fully realised the important part that initial condensation plays in the thermal efficiency of a steam engine, and his whole efforts were directed towards the design of an engine in the cylinders of which temperature difference should be reduced to the smallest possible range.

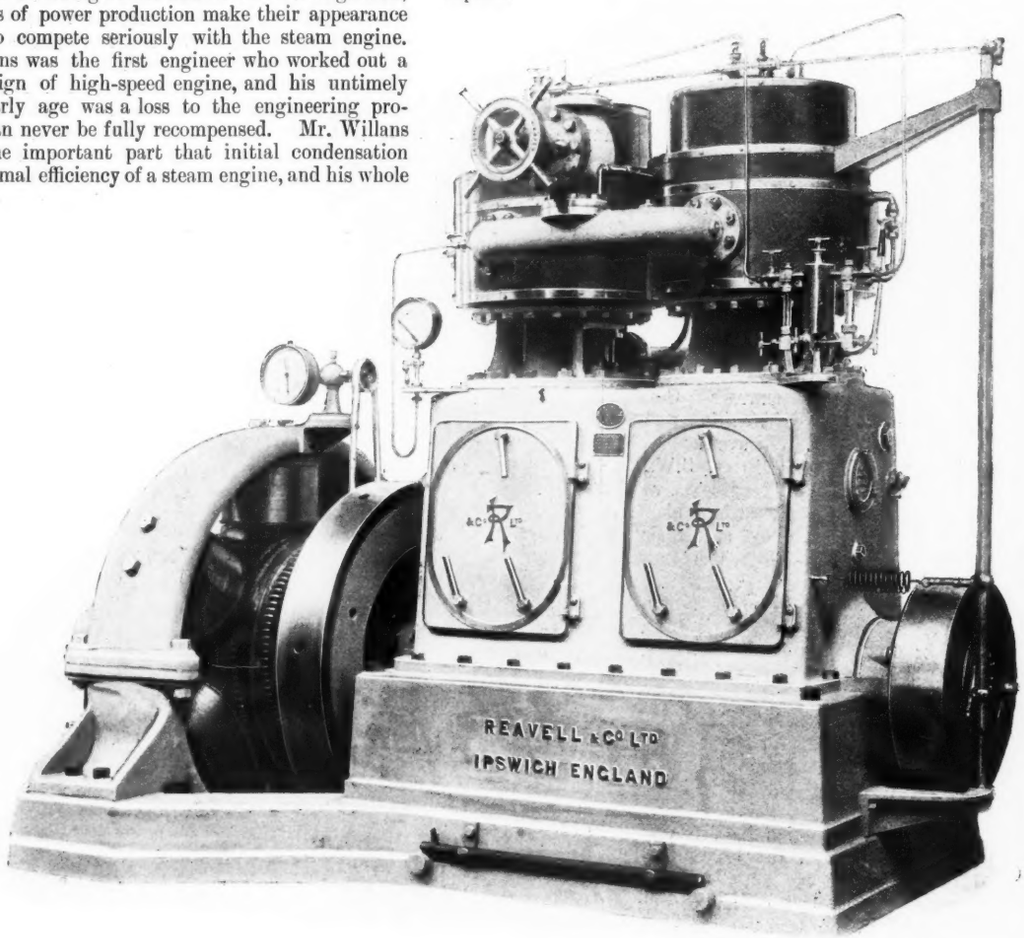


Fig. 1.

Messrs. Reavell & Co., of Ipswich, have introduced a design of high-speed engine which possesses some interesting features. As will be seen, it works on what is a development of the Cornish cycle, by which two separate stages of expansion are obtained, one on each side of the same piston in the same cylinder. Fig. 1 shows a Reavell engine of 160 I.H.P. direct connected to a dynamo, and fig. 2 shows a sectional elevation. From the latter it will be seen that steam from the boiler enters a chamber which surrounds the cylinder, thus acting as a steam jacket. Steam is admitted by a central valve which is actuated by a bellcrank and link worked from a point in the connecting rod, which gives a very rapid cut-off and maintains a nearly constant lead at all ratios of expansion.

The action is as follows :-

The steam enters through the stop valve and is admitted to the jacket surrounding the cylinder and inner cover. It then passes through into the top of the liner by the holes A. At the end of the down stroke, while the crank is turning on the bottom centre, a free passage is opened by the valve through the transfer ports E, enabling the steam to pass from above to below the piston. It must be borne in mind that the steam valve D (fig. 2), and the valve F, are in reality but one valve, having three port edges, one for admission, one for transfer, and one for exhaust, the valves being strung upon one spindle, and having no motion relative to each other. During about one-half of the up-stroke, the piston is in equilibrium, steam passing from above to below through the transfer ports without change of temperature or pressure, as will be seen from the diagrams (fig. 3). At a given point in the up-stroke, the piston itself overtakes the valve, and cuts off the transfer ports. Thereafter the steam above the piston is compressed, that below the piston continues to expand.

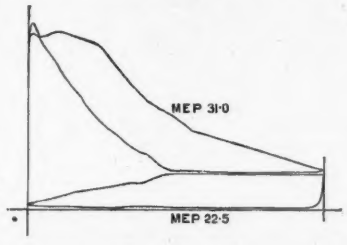
From the diagrams it will be seen that the steam is compressed up to admission pressure, and a proportion of the work necessary to effect this, is supplied by the expanding steam below the piston ; thus the important feature of high compression is partly effected by the expansion of steam on the under side of the piston, and as a result fluctuation in angular velocity per revolution is of necessity less than that of other constant thrust engines in which the work of compression of exhaust steam on the return stroke is done entirely at the expense of the energy of the moving masses.

It will be seen from the above that the Reavell engine may be termed double acting, in that steam acts upon both sides of the piston. On the other hand, however, the thrust is constant, which has hitherto been considered an attribute of the single-acting engine only. This constitutes the chief novelty of the Reavell engine.

Another feature of the design is the steam space surrounding the cylinder, which is always at admission temperature. As the steam from the boiler circulates through this chamber on its way to the cylinder, the temperature of

the latter is kept up, and initial condensation is thereby reduced. The advantages of this are manifest in the results of tests at light loads to which we refer later. Another point to be noticed is that the high compression of the steam takes up the momentum of the reciprocating parts, thereby ensuring constant thrust at all loads without the use of air buffers.

The governing is effected by rotating the steam valves by means of a governing bridge, B, and its forks.



Indicator Diagrams; Full Load (Governor Cylinder of Sutton Coldfield Set).

The steam ports are spiral, and therefore a very small rotation of the valve makes a large difference in the point of cut-off.

The workmanship is excellent throughout. As an instance of the class of fitting, we may mention that our representative disconnected the governor—the engine being run slow—and by means of a Salter's spring balance determined the pull necessary to rotate the valve above referred to. He found this to be about 3 lbs. for each valve.

Through the courtesy of Mr. William Reavell we were enabled to witness the official tests of a combined Reavell engine and General Electric dynamo for the Sutton Coldfield Corporation's electric light works, which have been designed by Mr. Hawtayne. Mr. Reavell has also supplied us with copies of the results of the official tests of similar sets for the Horsham electric light works and for the Dartford electric lighting works, these two works being also designed by Mr. Hawtayne.

The results obtained are shown in the tables.

The tests were all carried out in the testing room at Messrs. Reavell & Co.'s works, which is very completely equipped for this purpose, thus enabling the engines and dynamos to be very accurately tested either condensing or non-condensing before being sent out.

The engine shows a high degree of economy in steam consumption, even when running non-condensing.

Sutton Coldfield Set.

Size of engine, 21 in. diameter by 10 in. stroke; two cranks. Designed output, 300 amperes at 500 volts; dynamo direct-connected. Speed required, 350 r.p.m.

Non-Condensing.

Remarks.	Steam pressure lbs. per sq. in.	Speed revs. per min.	Amps.	Volts.	KW.	I.H.P.	Steam per hour per I.H.P.	Steam per hour per KW.	Combined efficiency.
Overload	151	338	362	499	180	289	19·75	31·75	83·7
Full load	150	346	300	500	150	245·8	19·12	31·3	82 %
¾-load	148	348	225	499	112·2	197·6	19·0	33·35	76·25 %
½-load	149	350	115·5	499	77·6	145·8	19·55	36·75	71·3 %

Horsham Set.

Size of engine, 17 in. diameter by 8 in. stroke; two cranks. Designed output, 160 amperes at 500 volts; dynamo direct-connected. Speed required, 400 r.p.m.

Non-Condensing.

Remarks.	Steam pressure lbs. per sq. in.	Speed revs. per min.	Amps.	Volts.	KW.	I.H.P.	Steam per hour. per I.H.P.	Steam per hour. per KW.	Combined efficiency.
Overload	149·6	398	215·7	463	99·8	163	19·33	31·54	82 %
Full load	151·0	401	175	465	81·7	137·4	18·35	31·2	79·6
¾-load	151·0	400	121·8	498·6	61·7	108·8	18·6	33·4	74·6
½-load	150·0	400	80·0	500·0	40	79·6	20·36	40·5	67·5

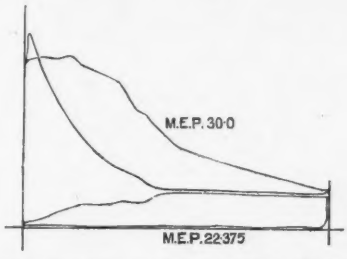
Dartford Set.

Size of engine, 17 in. diameter by 8 in. stroke; two cranks. Designed output, 200 amperes at 500 volts; dynamo direct-connected. Speed required, 450 r.p.m.

Condensing.

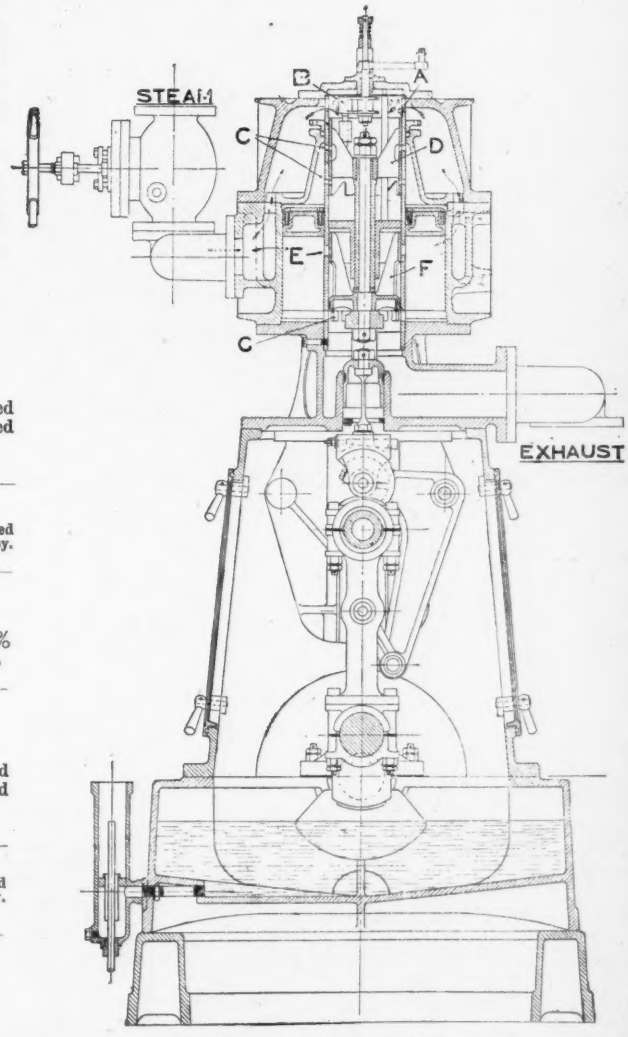
Remarks.	Press.	Vac.	Speed revs. per min.	Amps	Volts.	KW.	I.H.P.	Steam per hour. per I.H.P.	Steam per hour. per KW.	Combined efficiency.
Overload ...	149	25½	444	248·6	506	125·8	203·7	15·9	25·75	82·6
Full load ...	150	25½	446	199	500·4	100·2	159·5	15·43	24·7	84·0
¾-load ...	149	25½	448	149	505·5	75·3	125	15·6	25·94	80·75
½-load ...	151	26	453	100	500	50	88·1	15·65	27·65	76·0

The steam consumption in the Horsham set and the Dartford set is, we believe, the lowest that has as yet been



Diagrams from Cylinder next Fly-Wheel of Sutton Coldfield Set; Full Load.

obtained under similar conditions by any high speed engine non-condensing and condensing respectively.



Cross-Section of Reavell Engine.

ELECTRIC LIGHT AND POWER NOTES.

Barnes.—The D.C. has issued a writ against the County of London and Brush Provincial Electric Lighting Company, Limited, for supplying electrical energy within the Council's district.

Blackpool.—Something in the nature of a difference having occurred between the chairman of the Electric Lighting Committee (Alderman Grime) and the chairman of the Electric Tramways Committee, the former has resigned his position. The *Blackpool Times* calls the affair an "electrical rumpus," and all who take an interest in the matter will find some comments there anent in the December 18th issue of that newspaper. Mr. Grime was begged to recall his resignation, but has emphatically declined. There seems to have been some clashing or friction in regard to the administration of the two departments, and "rival reports" by the tramways manager, Mr. Lancaster, and Mr. Quin, the electrical engineer, were drawn up.

Coln Valley.—A combination of local authorities is being formed for the supply of electricity in the Coln Valley.

Dartford.—The electricity works of the U.D.C. was opened on Wednesday last week, and followed by an exhibition of electrical apparatus. The plant consists of two Lancashire boilers and economiser, supplied by Messrs. James Carter & Son; steam dynamos of 100 KW. output each, made by the General Electric Company (1900), Limited, and Messrs. Reavell & Co., Limited, and balancer booster by the G.E. Co.; condensing plant, supplied by Mr. G. S. de Ritter; storage battery of 83 amperes × 3 hours' capacity, by Messrs. Ashmore, Benson, Pease & Co., Limited; and switchboard by Messrs. Veritys, Limited. The mains and arc lamps were supplied by the Western Electric Company. Mr. Hawtayne is the consulting engineer.

Edmonton.—The D.C. has decided to oppose to the utmost the Bill of the North Metropolitan Electric Power Supply Company (which seeks powers to generate and supply electricity in the Council's district).

Falkirk.—The T.C. has approved of the appointment of Messrs. Burstall & Monkhouse, London, as consulting engineers for the scheme proposed under the provisional order. The Council has also resolved to borrow to the extent of £25,000 for the purpose.

Guildford.—In reply to the Corporation, the Electricity Supply Company have stated that they consider it premature to furnish information respecting their undertaking before the directors have been satisfied that the Corporation are *bonâ fide* purchasers, with expert advice behind their application. A reply has been sent to the company, stating that the Council cannot bind itself to purchase the undertaking without further investigation.

Hendon.—The adjourned inquiry into the loan of £36,400 for electric lighting purposes was resumed before Colonel A. J Hepper, D.S.O., R.E., on Thursday, December 12th. The opposition of the Mill Hill Grammar School was withdrawn, an undertaking having been given by the D.C. to apply at once for a supplementary loan of £5,910, with the object of extending the scheme to Mill Hill. A large number of witnesses were called in opposition to the scheme.

Kingston-on-Thames.—It is announced that the price for electrical energy will be at the rate of 7d. per unit for the first hour and 3d. for subsequent hours after June 24th, 1902.

London.—HAMMERSMITH.—The Borough Council has decided to lay new electricity mains for the northern part of the borough at an estimated cost of £9,540 odd. The work will include the laying of a low pressure distributing cable wherever ground is opened, and four 2-in. cast-iron pipes, two of which will be immediately occupied by two trunk high pressure feeders, and the other two will be spare ones. A long discussion arose as to the rate charged for the supply of electricity, particularly in the daytime. The electrical engineer had reported upon the subject to the Electricity Committee, who came to the conclusion that electricity might be sold during the daytime to large consumers for power purposes at 1½d. per unit, and still show a substantial profit. In order to check the consumption after 6.30 it would be necessary to fix a time-switch, for which a rental would have to be charged. The Council agreed with this view.

Maidstone.—The new electricity works was opened on Thursday last. The installation, which has cost about £40,000, has been carried out by the Corporation.

Riga.—The city authorities intend to lay down a large electricity works for the supply of this important port, which has a population of 300,000. The original installation will be of 1,000 to 1,200 H.P., but provision will be made for extensions up to 5,000 H.P. The whole project has been placed in the hands of Mr. Oscar von Miller, of München, who has carried out many similar undertakings on the Continent.

Stirling.—Since the electricity works was opened, numerous complaints have been made by house proprietors in the neighbourhood in regard to the vibration caused by the working of the engines, and the T.C., in order to remove the cause of complaint as much as possible, has just erected an exhaust silencer. Messrs. Babcock & Wilcox are doing the work, and installing a feed water heater also.

Sutton Coldfield.— The new electricity works was formally opened on 14th inst., and an electrical exhibition was afterwards held in the Town Hall. There are two Babcock and Wilcox boilers, fitted with superheaters and Green economiser; three dynamos of the General Electric Company's make, two of which are rated at 150 KW. and one at 50 KW., driven by high-speed engines manufactured by Messrs. Reavell & Co., Limited, of Ipswich. A balancer-booster set has been supplied by the G.E. Co., and a storage battery of 100 amperes × three hours' capacity by the E.P.S. Co, Ltd. The switchboard was made by Messrs. Mechan and Sons. The feeders are of the armoured concentric type, laid direct, and the distributors are separate cables laid on the solid system; all the cables were manufactured by Callender's Cable and Construction Company, Limited. Messrs. Johnson & Phillips's arc lamps and posts are used for public lighting, as well as incandescent lamps. Mr. Hawtayne is the consulting engineer to the Council.

Weybridge.—The plans of the Urban Electricity Supply Company as to cables have been approved by the U.D.C. The Council is asking the company to quote for lighting the street lamps after the expiration of the existing gas contract next September.

ELECTRIC TRACTION NOTES.

Barnsley.—To make provision of plant for the Barnsley and District Light Railways, the Council has decided that one of the 75-KW. generators be sold, and a 130-KW. generator substituted therefor, and, further, that the requisite traction switchboards be installed in accordance with the agreement with the company, at a total estimated cost of £2,000.

Bath.—The promoters of the electric tram scheme have written to the Electric Tramways Committee of the Council, asking for consent to various alterations in the scheme by abandoning certain routes and substituting others.

Batley.—Negotiations are proceeding between the British Electric Traction Company and the Batley Corporation by which an amicable arrangement is hoped for in regard to the working of the Dewsbury, Batley and Birstall tramway, the Corporation laying the line within its area, and leasing to the company and supplying the electric current. The completion of negotiations, of course, depends on the acceptance of terms as to rent.

Exeter.—The post-card poll of Exeter burgesses on the electric tram question shows that out of 9,074 voters, 6,584 showed enough interest to reply. Of these 5,187 favoured the introduction of trams, 1,384 opposing; and 4,950 favoured tramways through the main business thoroughfares, 1,621 opposing.

Hebden Bridge.—A dispute between the Halifax Corporation and the Hebden Bridge District Council as to which side of the road standard poles shall be placed on, has reached a deadlock which seems to prevent the extension of the Halifax tramway to Hebden Bridge for another 12 months.

Hounslow.—The owners and occupiers affected by the proposed extension of the L.U.T. from Southall to Heston oppose the proposal on account of the narrowness of the roadways.

Middlesex.—The Hendon U.D.C. has passed a resolution protesting against the arrangement made by the Middlesex C.C. with the London United Tramways Company in regard to the division of the County for the purpose of tramways.

Paignton.—At the last meeting of the D.C., Mr. Dart wished to move "that it is not desirable, in the interests of Paignton and district, that the surface contact system of tramways should be adopted," and after the passage of words between that gentleman and the chairman, it was decided to discuss the matter in committee.

Steam v. Electric Traction.—*Engineering* says:—"Some information has reached us from New York which is not altogether without importance. We refer to an announcement by the Pennsylvania Railroad Company of its intention to discontinue electric trolley traction between Mount Holly and Burlington, New Jersey, and to substitute steam for it. The trolley service was brought into operation in June, 1895, but the power house was recently burnt down, and the company has decided not to rebuild it. This is regarded as an indication that the management has come to the conclusion that electricity, as a motive power, is less satisfactory than steam. We regard this as an important announcement, because the Pennsylvania Railroad Company, which was incorporated so long since as 1846, is one of the largest, oldest, most prudent, and at the same time most progressive railway undertakings of the United States, as it is also one of the most prosperous. Not only, too, has the Pennsylvania Railroad Company discontinued the use of the electric trolley system upon one of its sections, but it has also ordered 400 additional steam locomotives for delivery upon its system in 1902, although 300 similar locomotives were built in its own shops, or by other firms and companies in the 12 months now drawing to a close."

TELEGRAPH AND TELEPHONE NOTES.

The Telephone Service.—It is stated that at the request of the London Reform Union Mr. Thomas Lough, M.P., has consented, when Parliament meets, to move the following amendment to the Address with reference to the telephone agreement:—

But we humbly express our regret to your Majesty that having regard to the promises made to this House during the recent Parliament by your Majesty's Government and to the report of the Committee that inquired into the question, your Majesty's Government should have entered into an agreement with the National Telephone Company with regard to the telephonic service in the metropolis without giving either to Parliament or to the local authorities of London an opportunity of considering the terms of the said agreement.

Underground Telegraphs.—The Liverpool Chamber of Commerce has written to the Postmaster-General strongly urging him to take steps immediately to place wires underground, in sufficient number for emergency purposes, between London, Liverpool, and other important commercial centres of the kingdom. The London Chamber of Commerce has also memorialised the Post Office on the subject.

Telegraph Rate Reductions.—The Eastern Telegraph Company, Limited, announce the following reduced rates per word which will be charged for telegrams "*viâ* Eastern" on and after January 1st:—Australasia, 3s. per word; South Africa, from 3s. ranging to 3s. 6d.; East Coast of Africa and islands, various rates ranging from 3s. to 3s. 8d.

CONTRACTS OPEN AND CLOSED.

OPEN.

Barking Town.—January 24th. Additional generating plant for the Council's electricity works. See "Official Notices" December 20th.

Barnstaple.—January 16th. Boilers, engines, dynamos, mains, &c., for the Town Council. See "Official Notices" December 13th.

Barrow-in-Furness.—Wiring the new Town Hall for the Corporation. C. F. Preston, town clerk.

Belgium.—March 1st. The municipal authorities of Ghent are inviting tenders until the March 1st, 1902, for the concession for an electric lighting installation. Tenders are to be sent by registered letter to La Collège, Echevinal, Ghent, while full particulars can be obtained from Le Bureau des Travaux.

Bournemouth.—January 6th. Feeder cables, pilot and arc lighting cables, and conduits, for the Corporation tramways. See "Official Notices" December 20th.

Chili.—The Chilian Government proposes to establish a cable connecting Punta Arenas and Puerto Mount. Estimates will be received at the Chilian Legation, London, where particulars of the undertaking can be obtained.

Egypt.—January 18th. Electric lighting of Suez and Damanhour. Particulars from the Minister of Public Works, Cairo.

Grimsby.—January 20th. Steam dynamos, switchboard extensions, battery, condenser, piping, water-tube boiler for electricity works. See "Official Notices" to-day.

Hornsey.—January 15th. Pipework and mechanical coal-handling plant for electricity works for the U.D.C. See "Official Notices" December 6th.

Kirkcaldy.—January 8th. Piping, pumps, feed heater, &c., for electricity works. See "Official Notices" December 13th.

Manchester.—January 21st. Three-phase switchboards, exciter and auxiliary ditto, three-phase boards for sub-stations, low tension boards at sub-stations at the Stuart Street generating station. See "Official Notices" December 20th.

Middlesbrough.—January 21st. 300-KW. engine and dynamo, switchboard panels, ejector condenser, feed pump and economiser for the electricity works. See "Official Notices" December 20th.

Nantwich.—January 6th. Water-tube and Lancashire boilers, steam dynamos, pumps and piping, switchboard, mains, posts, battery, meters, crane and dust destructor for the U.D.C. See "Official Notices" November 22nd.

Reading.—December 28th. Water-tube boilers, economiser, pumps, engines, condensing plant, generators, switchboard, crane, motors and car equipments, car bodies, trolleys, &c., for the Corporation. Borough engineer's office, Town Hall. Specifications &c. 10 guineas.

Roumania.—December 30th. Tenders to the Roumanian Post and Telegraph authorities in Bucharest, for the supply of 5 tons of bronze wire 1½ mm. diameter. Tenders are to be sent to La Direction des Postes et des Telegraphes, Bucharest, whence particulars may be obtained

Stepney.—January 9th. Hire purchase or assisted wiring proposals are wanted by the Borough Council. See "Official Notices" to-day.

Warrington.—December 31st. Electric light mains and fittings at the tramways car depôt for the Tramways Committee. See "Official Notices" December 13th.

Warrington.—January 4th. Tramway shop equipment and switchboard extensions for the Corporation. See "Official Notices" December 20th.

West Bromwich.—January 17th. Rails, points, crossings, drain rails, road work, bonding, trolley poles, overhead line work, section boxes, cables, &c., for electric tramways for the Council. See "Official Notices" December 20th.

West Ham.—January 14th. Surface condensing plant and travelling crane for the electricity works. See "Official Notices" December 13th.

CLOSED.

Cardiff.—The Corporation has accepted the tender of the British Insulated Wire Company for cables, at £12,656 4s. 2d.

Hoylake and West Kirby.—The D.C. has approved of a draft contract for the supply of a new motor-alternator by the International Electrical Engineering Company.

London.—We are informed that the contracts for electric supplies, 1902—3, of the New Zealand Royal Mail steamers and two other important Royal Mail steamship companies have been placed with Messrs. H. Binko & Co.

FORTHCOMING EVENTS.

Saturday, December 28th.—At 3 p.m. Royal Institution. Lecture I., on "Waves and Ripples in Water, Air and Æther," by Prof. J. A. Fleming, F.R.S.

NOTES.

The Compliments of the Season.—A Happy and Prosperous New Year to all readers and friends of the Electrical Review!

London County Council.—The Council decided at the meeting on 17th inst. to lend £6,310 to the St. Pancras Borough Council for electric lighting purposes.

The Highways Committee reminded the meeting that under an agreement between the Council and Prof. Kennedy, the latter was acting as engineer-in-charge of the work of reconstructing for electric traction the tramways between Westminster and Blackfriars and Tooting and Waterloo Road and St. George's Circus. On the other hand, the Council's electrical engineer, Mr. Rider, was preparing the plans, drawings and specifications for, among other matters, the mains and feeders which would be required in connection with the conversion of other parts of the tramways, and it had been suggested to the Committee that it would be a convenient arrangement if he were to do the same as regarded the mains and feeders needed for the tramways which were to be transformed under the supervision of the consulting engineer. The Committee had ascertained that Prof. Kennedy was prepared to acquiesce in the proposed arrangement, an amount equivalent to the commission which he was entitled to receive upon that work being paid to him in respect of electric cars in addition to the number specified in the agreement. In the opinion of the Committee, the proposal would be an equitable arrangement, especially as the consulting engineer did not propose to make any charge in respect of his work in connection with the scheme, which has now been abandoned, for the erection of a generating station at the Camberwell tramway depôt. On the recommendation of the Committee, the Council sanctioned the suggested modification of the agreement.

Lighting of a Home.—It was announced by the Inebriates' Act Committee that consideration had been given to the question of lighting the new buildings at Farmfield, and they had come to the conclusion that electricity would not only be the most economical, but also the most suitable in view of the class of women detained in the premises. The engineer's estimate of the work amounted to £1,750, and included the supply of a supplemental engine, dynamos, cells and switchboard, outside mains, wiring and fittings. It was decided to sanction the carrying out of the work.

Elevator for Clacton.—The Clacton Urban Council has agreed to the application of the Reno Elevated Construction Syndicate for a concession to construct an electric stairway up the face of the cliff.

Dinners and Diners.—On Saturday evening last the staff of Messrs. Johnson & Phillips were invited to dinner at the Trocadero by Mr. W. Claude Johnson, on the occasion of the twenty-fifth anniversary of the foundation of the firm. We regret that having to go to press three days earlier than usual we can devote but little space to this most interesting celebration. There were places at the tables for 174 guests, Mr. Johnson occupying the chair, and Messrs. Macgregor, Pearson, Vecqueray, Paterson, Hughes, and Esson presiding at the six side tables. The toast list was commendably brief, and in proposing "Prosperity to the Firm" Mr. W. B. Esson was alternately grave and gay. He told us he meant to be funny, but at the conclusion of his speech he expressed doubts as to whether his jocularity had been appreciated at its true worth. Somebody called it the very quintessons of Scotch humour. "The Health of the Staff" was proposed in felicitous terms by the chairman, that of the "Chairman" by Mr. J. Macgregor, the ubiquitous manager, who was so much in evidence that the meeting might have fairly been termed "The Macgregors' Gathering." The remaining toast was that of the "Visitors and Press." After dinner Dr. Byrd-Page, the well-known prestidigitateur, performed some very remarkable conjuring tricks, and Mr. Johnson and several members of the staff entertained the company with songs. A prettily got up "souvenir" of the dinner was a four-page illustrated programme, which threw some light on the progress of the firm. In 1876 a 4-H.P. engine and boiler supplied the power for the old works; to-day the power developed exceeds 2,500 H.P. To us the most significant feature of the celebration was the mutual good-fellowship, esteem, and regard which evidently exists between Mr. Johnson and his staff. He credits his co-workers with having raised him to the position he now occupies; the staff find Mr. Johnson invariably ready and willing to help them out of any difficulty which may arise in any one of the numerous departments of the works. The reason of the firm's prosperity is therefore not far to seek, for with such kindly feeling between principal and staff and up-to-date methods of manufacture—Mr. Esson has no fear of foreign competition—it would be strange if success were not theirs. Mr. Johnson may be heartily congratulated on having such a little army of skilled and energetic men under his authority, and the staff may consider themselves equally fortunate in being controlled by so able a guide, philosopher and friend as the well-known head of the firm of Messrs. Johnson & Phillips.

Municipal Finance at Goole.—Colonel Hepper, D.S.O., C.E., and Mr. Burd, inspectors of the Local Government Board, held an inquiry at Goole recently into an application of the Urban Council to borrow close upon £19,000 for gas and waterworks purposes.

Replying to Mr. Burd, Mr. England said that the gross profits from the concern during the past year amounted to £9,013.

Mr. Burd: What has become of the money?

Mr. England: It has been expended by the Council for the payment of some of these things. Others have been paid out of revenue, though they were capital expenditure, and we decided to apply for the loan when all the work was completed.

Replying to further questions, Mr. England admitted that the revenue account had been overdrawn at the bank £11,478, and the purpose of the proposed loan was to repay that.

"We were doing the work piecemeal, and I advised the Council it would be better to apply when the work was completed. We borrowed the money from the treasurer, and I made a similar statement to the auditor as to applying when the work was completed, and we then allowed it to go on until at last he stopped it, and the Local Government Board surcharged us, but ultimately, on appeal, they remitted the surcharge. We have spent £10,000 to £12,000 from a loan of £15,000 which we have obtained for another matter. We had an Act in 1899 for the Pollington supply, and we have not yet completed the carrying out of these works, and we have temporarily applied that to the reduction of the treasurer's balance."

Mr. Burd: And do you consider that proper finance?

Mr. England: I don't now, sir; but we want to get out of our difficulties as soon as we can.

Comment is needless.

Atlantic Wireless Telegraphy.—The following letter on the recent alleged achievement of Mr. Marconi appeared in the *Times* on 20th inst. from the pen of Dr. Oliver Lodge, at the University of Birmingham:—"It is rash to express an opinion either way as to the probability of the correctness of Mr. Marconi's evidently genuine impression that he has obtained evidence on the other side of the Atlantic of electrical disturbances purposely made on this side, but I sincerely trust that he is not deceived. He has probably been using as detector the very simple device depicted in my little book on the subject published by the *Electrician*, page 27; and I know how sensitive this plan is, for with it messages could be easily heard across the Bristol Channel at Weston-super-Mare with a pole only 12 ft. high; hence I am not indisposed to credit the assertion that with great power on one side a faint trace could be perceived on the other side even of the Atlantic. The danger of referring even hypothetically to such subjects lies in the fact that needless financial disturbances are sometimes brought about; but, as I have expressed myself critically on some of the early achievements of Mr. Marconi, which from the first were erroneously heralded before the British public as scientific novelties, I should not like to be behindhand in welcoming, even prematurely, the possibility of so immense and barely expected an increase of range as now appears to be foreshadowed. Proof, of course, is still absent, but by making the announcement in an incautious and enthusiastic manner Mr. Marconi has awakened sympathy and a hope that his energy and enterprise may not turn out to have been deceived by the unwonted electrical dryness of the atmosphere on that wintry shore."

In response to Prof. Lodge's letter, Major Flood Page says:—"Prof. Oliver Lodge is altogether wrong in his suggestion that Marconi was 'using as detector the very simple device depicted in my little book on the subject.' If this 'simple device,' described in a 'little book,' had been the means by which Marconi had received communication from a distance of 2,170 statute miles, it would not have made the fact of the communication less wonderful, but Mr. Marconi was using something that Principal Lodge has never yet seen. Every advance in scientific industry is always met with doubt, and cavillers are numerous. It is so in this case. It was the same when Marconi communicated at a distance of 14 miles, of 50, and still more of 200 miles, and so it will be until such communication across the Atlantic and further has become a matter of daily use, of hourly experience."

A Laffan dispatch from New York, says, "the *Electrical Review*, prints a telegram from Signor Marconi in which he fully confirms the success of his experiments, and adds that he intends to read a paper on the subject before a scientific society as soon as possible."

The *Times* St. Johns correspondent on 22nd inst., telegraphed that "the Canadian Government has offered Mr. Marconi every facility to operate on Canadian territory, and has invited him to Ottawa. He has accepted, and goes there on Tuesday."

Institution of Electrical Engineers (Dublin Section).—The Dublin Section met in the College of Science on the 19th inst, Colonel Beresford, C.R.E., Ireland, presiding in the first instance. The chairman regretted that the exigencies of the Service prevented him from accepting the presidency of the Section. In acknowledging a vote of thanks for his service, he said he had long advocated that each regiment should have its own field equipment. He believed that the great loss at Spion Kop was due largely to the want of telegraphists on the field. Subsequently, Prof. Barrett took the chair, and delivered a very interesting lecture on the progress that the Institution had made since it was founded in 1871 in membership, which was now close on 4,000, and in finances the vested money being nearly £20,000, and the annual income over £6,000. In the concluding portion of his address he deplored the want of technical education in Ireland, instancing the fact that there was not a single endowed Chair of Electrical Engineering or Mechanical Engineering in the country.

Departure of Electrical Volunteers.—On Friday last the fourth company of Electrical Engineer Volunteers, 50 strong, left for South Africa. They had a very enthusiastic send off at Waterloo Station. The company goes out under Captain Brady, Royal Engineers, Adjutant of the Volunteer Corps. The *Standard* says that as they marched into the station from the muster point at the Electrical Engineers' Drill Hall in Regency Street, Westminster, the men showed good equipment and smartness. They were dressed in the usual South African costume, covered by the warm greatcoats needful on such a morning, carried rifles, and wore bandoliers, belts, haversacks, and water bottles, the rest of their equipment going in kit bags. The strength of the corps in South Africa will thus be brought up to nearly 200, and another company is being got ready for departure in January, under Lieutenant Stubbs, whilst quite 300 names of men ready to join further service companies have been received at headquarters. Lieutenant Stubbs was at Waterloo to see the company go off, several other officers of the corps also being present, including Captain Phillips and Captain Leaf.

Horses Electrocuted.—Our Wolverhampton correspondent says that, during the storm in Dudley, telegraph and telephone wires were brought to the ground, and through the inadequacy of the system of guard wires, brought with them the current running along the tramway wires. A pair of black horses came into contact with these broken wires at Netherton, and were instantly killed. Wm. Edwards, the driver of the hearse, also received an electric shock, but was not seriously injured. A similar accident occurred at Woodside, where a horse belonging to Messrs. Preece, grocers, was electrocuted.

High-speed Engines.—Mr. J. H. Dale's paper on "High-speed Engines" in *Feilden's Magazine* is rather a piece of special pleading for the high-speed type of the high-rotation variety, but the author clearly recognises the weakness of the high-speed engine in its low piston speed. High-speed engines are credited with occupying little room: actually they are big for their power, but having such very short strokes, they are kept into moderate bulk. We do not think much of his argument about locomotives only running about two hours at one time, as this has not much bearing on the working parts, but rather on the steam running department, and locomotives, if wanted to run for a week, would have been made to do so by self-adjustment. Doubtless short-stroke engines at high rotative speeds have shown that saturated steam can be better worked on them than in engines of long and slow stroke. But has this ever been shown to be the case with superheated steam? The high-speed engine has been a success quite apart from thermodynamic causes; it has been so convenient for driving dynamos, but all that is claimed for it cannot be conceded. True, the older type of engine cost more and demanded larger buildings, but it is doubtful if the old engines were more liable to breakdowns or required more attention. It may be admitted that forces generated at high speeds are altogether beyond those generated at low speeds, and that much knowledge has been accumulated by testing

to destruction. But these tests to destruction of high-speed engines have been the means of teaching in the school of experience. It has been said that "Experience keeps a dear school, and fools will learn in no other." This is peculiarly applicable to the high-speed engine history. Long before any high-speed engine now existing was ever thought of, the laws of centrifugal force were thoroughly understood, so also were the laws of inertia and acceleration, and Wöhler's laws of stress with special reference to stress reversal were but the statement in words of what Fairbairn showed experimentally in Manchester in connection, we believe, with Eaton Hodgkinson. Yet how many high-speed engine designers have given a thought to these matters in their engines until compelled to do so by the testing to destruction to which they unintentionally condemned their creations? Why did the most enlightened investigators begin with light shafts, as our author states they did? The light shafts of many of the early engines that failed so lamentably could have been calculated without the difficulty named. If a designer simply takes an old-fashioned rule for shafts and applies it to a high-speed single-acting engine, and does not double the strength for the single-acting design, and pretty nearly double this again for other reasons, such as air buffers, &c., he ought not to feel hurt if his shafts continue to go, even when he has added a timid ½ in. in place of an extra 1 in. to his diameter. It cannot be called designing an engine when alterations of such importance are only made under the compulsion of breakdown. Will the author substantiate his statement that oil at 1s. per gallon answers perfectly well for high-speed engines? This is not so by any means. There are scores of users of high-speed engines to-day who would be glad to be set free of what they regard as the tyranny of the crank chamber oil man, to whom they are paying nearer 4s. than 1s. If a long stroke engine runs away it will smash. Quite so, but why should it run away? Has Mr. Dale never heard of knock-off motions? The remainder of Mr. Dale's article is less debateable. The high-speed engine is demanded to fill certain duties, and has grown to a very excellent machine, but it has not all the virtues its friends claim for it, nor has its evolution been altogether a credit to engineering mathematics. Indeed, the majority of high-speed engines seem to have been left to grow, and only those have survived that have had very substantial backing.

To Electrical Manufacturers.—Mr. W. Wyld, the borough electrical engineer of Doncaster, informs us that it has been decided to hold an electrical exhibition in Doncaster sometime in January next. Manufacturers of plant who care to send down exhibits should communicate with Mr. Wyld as soon as possible. Every facility will be given them, no charges whatever being made, and it is possible, too, that current will be supplied free of charge to drive small motors, fans, heaters, radiators, &c., this of course depending upon the nature and the amount of the demand.

Chamberlain & Hookham, Limited, v. Bradford Corporation.—On Friday last judgment was given in this case in the Court of Appeal by Lords Justices Vaughan-Williams, Romer and Cozens-Hardy. The hearing of the appeal has already been reported at length in our columns. The appeal was dismissed with costs.

Liverpool Engineering Society.—Before this society on 18th inst. a paper on "High Speed Steam Engines," was read by Mr. Davidson.

Croydon Tramways.—The Tramways Committee considered an application on behalf of the British Electric Traction Company, Limited, for 10 additional new cars to be ordered to be in readiness for the forthcoming summer, and recommended that tenders be invited for 10 cars of a larger type than those at present in use. The present cars are constructed to carry, inside and out, 70 passengers. These new cars will be used entirely on the main route. The estimated cost of the cars is from £700 to £800 each. The report was agreed to.

Obituary.—Mr. C. Fellows, electrician at Windsor Castle to the late Queen Victoria, died at Windsor somewhat suddenly on Saturday last. The deceased had only recently taken his pension.

Drop Forging.—Mr. E. Rudland Wood writes to us as follows:—"In reply to 'Werdna,' I have pleasure in offering the following information:—Drop forging is the term applied to that class of forging which is done by the 'dropping of a weight' suspended by suitable ropes from a specially-constructed rotary engine worked by levers manipulated by foot or hand from the 'anvil' floor. The metal to be treated is heated to a bright red, and held in 'dies' of the desired shape, and the weight is allowed to fall on the top of the 'dies' repeatedly until the 'forging' is completed, the force of 'blow' being regulated by altering length of drop of the weight."

Physical Society.—At the ordinary meeting held December 13th, 1901, Prof. S P. Thompson, president, in the chair, the following paper was read by the secretary:—"On Circular Filaments or Circular Magnetic Shells Equivalent to Circular Coils, and on the Equivalent Radius of a Coil," by Prof. T. R. Lyle. It is shown that we can represent the magnetic action of any coil by replacing it by one or more filamentary circuits in which currents circulate, bearing a simple relation to the actual current in the coil. If the axial and radial dimensions of the coil in question are the same, then the external magnetic action can be represented by that of one filamentary circuit. If the axial breadth is greater than the radial depth, we must employ two filaments of equal radii separated by an axial distance, and if the opposite condition holds, two circular filaments of different radii lying in the same plane perpendicular to the axis of figure of the coil. In the case of coils in which the axial and radial dimensions are equal, a modification of Bosscha's method is described which yields the equivalent radii directly as the result of length measurements. If the axial and radial dimensions are not equal, it is shown that the method is still applicable, provided that the ratio of the resistances of the Bosscha comparison be altered in a ratio depending on these dimensions. Apparatus for carrying out the experiment is described, and applications to some classical cases are given. It is also pointed out that the correction for finite length of magnet in Bosscha's (or the present) method of comparison is, in general, far from negligible. The formulæ used are based on the expansion of the potential of a coil for points on its axis, and terms up to the fourth have been included, but the effect of neglecting higher terms is not investigated.

The secretary read a letter from Lord Rayleigh in which he stated that the length of the magnet used in determining the constant of the current balance used in the determination of the electro-chemical equivalent of silver was $\frac{1}{10}$th of an inch, and the error due to neglecting this was less than one part in 10,000. Mr. W. Watson expressed his interest in the method because it reduced the ordinary arithmetical calculations, and drew attention to some advantages of the practical applications.

The chairman said it was a useful step to reduce the action of a rectangular coil to that of two filaments. In the case of a tangent galvanometer with one coil, if the channel is cut to take nine turns axially and 11 radially, then the equivalent radius is equal to the mean radius.

Manchester and Liverpool Express Railway.—The *Times* Berlin correspondent says that on 18th inst. Mr. F. B. Behr delivered a lecture at the Berlin Architektenhaus to the Berlin section of the Association of German Engineers on "Electrical High Speed Railways and the Projected Mono-Rail Line between Manchester and Liverpool." Comparing the proposed mono-rail with the Berlin—Zossen experiment, Mr. Behr pointed out that in the latter case the carriage used weighed 94 tons, carried 45 passengers, and required 3,000 H.P. during acceleration, and 1,100 H.P. on the rest of the journey. These figures were more than double those which were required for the Manchester—Liverpool line. The carriage there weighed only 39 tons for 38 passengers, and required 1,100 H.P. during acceleration and 515 H.P. for the rest of the journey. This showed that in the Zossen experiment at least double the amount of electricity was consumed per passenger and double the amount of current was generated. Further, the height of the carriage on the Berlin-Zossen line, being more than double that to be used on the Manchester—Liverpool line, would entail a large additional expenditure for the enormous height of the overbridges, and the increased weight on the underbridges and sleepers, which was really double that on the Manchester—Liverpool line, would make it impossible to build such lines with any hope of commercial success. In conclusion, Mr. Behr urged the German engineers carefully to compare the economical and technical results of the two systems in order that they might choose the type that was both safest and cheapest. The lecture was followed by a discussion, which dealt chiefly with Mr. Behr's criticisms on the experiments at Zossen. The first speaker, a representative of the Allgemeine Electricitäts-Gesellschaft, defended at some length the Zossen experiments, and asserted that it was possible to attain both high speed and safety on an ordinary permanent way with double rails. He questioned the smoothness of the working of Mr. Behr's mono-rail system where there were sharp curves. Mr. Behr stated in reply that he himself had been able to stand steadily in his motor carriage on his experimental mono-rail line at Brussels while it was rounding the sharpest curves at high speeds. All these criticisms and more had been advanced during the exhaustive investigation of his scheme by the Parliamentary Committee, and had not been supported by any English engineer of standing. Herr Lochner also spoke in defence of the Zossen experiments, and maintained that on an ordinary double-rail line, where the rails weighed 34 kilogrammes per metre, it was possible to attain a speed of 180 kilometres an hour with perfect safety. He explained the refusal of the authorities to permit Mr. Behr to be present at the experiments at Zossen, by saying that those responsible for the experiments were unwilling to guarantee compensation for the loss of Mr. Behr's life, and had made it a condition that he should be specially insured—a statement which provoked some amusement.

Sanding of Tram Tracks.—In the case of Fitzgerald *v.* The Dublin United Tramway Company, heard before the Judges of the Court of Appeal, Dublin, last week, in which the point involved was whether or not the defendants (the appellants) were liable for the sanding of the tram tracks, the plaintiff had been awarded £1,000 damage for personal injuries received through the slipping of his horse between the tram rails in Grafton Street. The three judges (Fitzgibbon, Walker and Holmes) were unanimous in dismissing the appeal with costs. The case will now be brought to the House of Lords.

Appointment Vacant.—A distributing engineer for the Hackney Borough Council at £250 per annum.

Harry South & Co., Limited.—In the Companies Winding Up Court of the High Court of Justice, on Saturday, a petition for the compulsory winding up Harry South & Co., electricians, presented by S. Tilney, came on for hearing.—Mr. Gore Brown said it was a creditors' petition, and it had stood over to see if anything could be done towards paying the debts of the company. No offer which could be accepted had, however, been made, and therefore he asked for a compulsory order.—Counsel for the company said that his instructions were that if the matter was allowed to stand over until the next sitting an arrangement would be made satisfactory to Mr. Brown's clients.—Mr. Brown said the matter had been going on for a long time, and he must press for an order.—His Lordship: You don't think the offer is *bond fide*.—Mr. Gore Brown: No, I do not, my Lord.—His Lordship: The order must go unless some substantial offer is made.—Counsel for the company: Suppose we deposit £200 on Monday morning?—Mr. Gore Brown: Our debt is £500.—Counsel for the company: We are prepared to deposit £300.—His Lordship: If you wait a little longer, Mr. Brown, you will perhaps get more. Eventually his Lordship made the compulsory order asked for.

The Mersey Railway.—Arrangements for commencing the electrification of the Mersey Railway are now far advanced. The Westinghouse Company are erecting temporary works in Shore Road, Birkenhead, to serve as a basis of operations during the progress of the work. It is intended to make a start with the new year, and it is expected that about 600 men will be employed on the work. The intention is to carry on the operations during the night, so as not to interfere with the daily service through the Mersey tunnel until the final connections have to be made.

Copper.—1887 to 1901.—It is interesting to look into the movements of the Copper Market over the past 14 or 15 years. The Secretan boom began in 1887, when the year opened with copper at £38 a ton, and it continued at about this figure until November, when the price rose to 44, and then in the following month went suddenly to £68 per ton. In January, 1888, it had reached as high as £85, but the next month saw a sudden drop of £10, which was only partly made up throughout the summer of that year, when the price remained fairly steady between £79 and £81 a ton. In September of 1888, the highest figures were reached, the average monthly price of G.M.B. copper being £89, whilst on one day the figures actually touched £105 a ton. By the March of the following year (1889) the price had dropped to £79, and directly after that, came the break-up, the figures in April being £40, and in May only £38, which is exactly where it was before the boom. Since that troubled period copper has sunk as low as £37 17s. 6d., viz., in the summer of 1894. The effect of the recent inflation of the market by the Amalgamated Company has been more lasting, as their operations seem to have affected the market since October, 1898, when the average monthly price of G.M.B.'s was £53. Rising steadily it reached an average of £73 a ton during February, 1899, and was up to £77 in May, although on one day the price of £79 was touched. These figures were about maintained until October, when the average monthly price was only £75—next month the price was £72, and in January, 1900, it was only £70. In April, 1900, it was back at £79, and kept fairly steady for fully 12 months at between £71 and £73. From that time it has gradually declined, until on Wednesday last week, December 18th, the price was £50,

NEW COMPANIES REGISTERED.

Geneva Tramways Company, Limited (72,081).—This company was registered on December 6th, with a capital of £850,000 in £1 shares, to carry on in the City of Geneva and elsewhere, the business of a tramway company, to hold shares and securities of any British or foreign tramway companies, to acquire all or any of the shares in La Compagnie Genevoise des Tramways Electriques, with all or any of the founders' certificates issued by that company, and the exclusive interest therein, to adopt an agreement between L. Hirsch & Co. of the one part, and William Bayley (for this company) of the other part, to acquire or construct, equip and work any tramways or light railways, to manufacture and deal in mechanical, electrical and other appliances for use in connection therewith, and in particular to make and supply carriages, trucks, locomotives and motors of every size and kind, and dynamos and electrical machinery, and to carry on the business of engineers, contractors, passenger and transport agents, financiers, &c. The first subscribers (each with one share) are:—C. S. Heathfield, Glamorgan Road, Hampton Wick, clerk; E. J. Burridge, 106, Fentiman Road, Clapham, S.W., clerk; H. H. H. Parks, 8, Canterbury Road, West Croydon, accountant; J. R. Dutton, 55, Comerford Road, Brockley, S.E., clerk; T. A. England, 4, Devoncroft Villas, Twickenham, clerk; A. Vandyck, 8, Rosemount Mansions, Lithos Road, Finchley Road, N.W., accountant; and G. H. Kennedy, 59, Ferndale Road, Clapham, S.W., clerk. Minimum cash subscription half the shares offered to the public. The number of directors is not to be less than two nor more than seven; the first are the Hon. Arthur G. Brand, M. Henri Bousquet, Henry A. Butters and Arthur M. Grenfell, with one other to be appointed by the subscribers.

William Rickard, Limited (71,097).—This company was registered on December 7th, with a capital of £50,000 in £1 shares, to acquire and take over as a going concern the business of an electrical wire and cable manufacturer, and manufacturer of millinery wires and trimmings now carried on by Agnes Rickard (an executrix of the late Douglas Rickard), at Ashbourne Road Mills, Derby, under the style of William Rickard, to adopt an agreement between the said Agnes Rickard of the first part, and Reuben Dunsford of the second part, and to carry on the business of manufacturers of and dealers in electrical plant, machinery, appliances, products, and accessories, iron, steel and metal merchants, wire drawers, galvanisers, annealers, tube manufacturers, shippers and general merchants, &c. The first subscribers (each with one share) are:—F. H. Smith, The Priory, Swinton Park, near Manchester, manufacturer; P. A. Birley, Thorn Lea, Prestwich, near Manchester, manufacturer; F. J. Taylor, Overdale, Bakewell, solicitor; Mrs. A. Rickard, Friargate House, Derby; R. Dunsford, 81, Radbourne Street, Derby, manager; L. Clay, Thornleigh, Wilmslow, Cheshire, secretary; and E. Feather, Station Road, Mickleover, near Derby, book-keeper. No initial public issue. The number of directors is not to be less than three nor more than seven; the first are Philip A. Birley, Reuben Dunsford, Frederick H. Smith and Francis J. Taylor. Remuneration for first two years £500 per annum divisible; afterwards as fixed by the company. Registered office, Chandos Pole Street, Ashbourne Road, Derby.

Swiss Railway Syndicate, Limited (72,109).—This company was registered on December 9th, with a capital of £8,055 in 8,000 ordinary shares of £1 each and 1,100 deferred shares of 1s. each, to acquire a concession for an electric railway between Chamounix and Martigny, or any point between those places, to construct or finance the construction of such railway, and to acquire or construct, maintain, work and control any railways, tramways, waterways, waterworks, roadways, harbours, docks, &c. The first subscribers (each with one share) are:—H. C. Warner, 10, Finsbury Circus, E.C. solicitor; A. Balderson, 27, Crofton Park Road, cashier; J. Thompson, 11, Finsbury Circus, E.C., commissionaire; E. E. Sawyer, 20, Devonshire Terrace, Lancaster Gate, W., civil engineer; C. C. Macrae, 4, Bank Buildings, E.C., barrister-at-law; W. Chamberlain, 4, Bank Buildings, E.C., secretary; and A. W. W. Hall, 71, Cleveden Gardens, Barnes, S.W., secretary. No initial public issue. The number of directors is not to be less than two nor more than four; the subscribers are to appoint the first; qualification, 500 ordinary or 100 deferred shares; remuneration, £50 each per annum (£100 for the chairman), to be increased according to profits. Registered office, 11, Queen Victoria Street, E.C.

Paris Singer Electric Carriage Company, Limited (72,171).—This company was registered on December 14th, with a capital of £500 in £1 shares, to manufacture, sell, let on hire or otherwise deal with electric motors, cycles, carriages, vehicles, launches, flying machines and the like, and their parts and accessories. The first subscribers (each with one share) are:—G. F. Seagrave, 69, Falkland Road, Hornsey, N., accountant; H. H. Fox, 2, Brick Court, Middle Temple, solicitor; J. Woodall, 56, Oakley Road, Canonbury, N., clerk; F. W. Bumpster, 35, Arundel Square, N., clerk; E. Wallace, 56, Mornington Road, N.W., law stationer; J. P. Eldridge, 16, Marlborough Road, Bowes Park, N., clerk; and L. Rendell, 5, Hanover Mansions, Maddox Street, W., solicitor. No initial public issue. Registered without articles of association.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Montevideo Telephone Company, Limited (27,208).—This company's annual return was filed on November 21st, when 86,492 preference and 72,680 ordinary shares were taken up out of a nominal capital of £160,000 in 87,000 preference and 73,000 ordinary shares of £1 each. £1 per share has been called up, resulting in the receipt of £159,172. No mortgages or charges.

Chloride Electrical Storage Syndicate, Limited (35,389).—This company's annual return was filed on December 5th, when all the "A," "B," and founders', and 100,000 "C" shares were taken up out of a nominal capital of £262,500 in 80,000 "A," 30,000 "B," 140,000 "C," and 12,500 founders' shares, all of £1 each. £1 has been called up on each of 65,000 "A" shares, and £65,000 has been received. £157,500 is considered as paid, on 15,000 "A," 30,000 "B," 100,000 "C," and 12,500 founders' shares. Mortgages and charges, *nil*.

Johnson-Lundell Electric Traction Company, Limited 65,699.—This company's annual return was filed on October 23rd, when all the partly-paid and fully-paid deferred, and 3,228 fully-paid shares were taken up out of a nominal capital of £300,000 in 40,000 partly paid, 4,000 fully-paid, and 16,000 fully-paid deferred shares of £5 each. £3 per share has been called up on 40,000, resulting in the receipt of £108,822. £11,178 remains in arrears. £96,140 is considered as paid on 3,228 fully-paid and 16,000 fully-paid deferred shares. Mortgages and charges, *nil*.

Walsall Electrical Company, Limited (37,696).—This company's annual return was filed on October 21st, when 16,380 shares were taken up out of a nominal capital of £25,000 in 25,000 shares of £1 each. £1 has been paid on 14,380 shares, 2,000 are considered as fully paid. Mortgages and charges *nil*.

SUPPLY STATION ACCOUNTS.

Halifax Corporation Electricity Accounts.

Two years ago we were able to congratulate Mr. H. F. Street, the borough electrical engineer of Halifax, upon the turning of the corner of his department, whereby the deficit which had marked the accounts of the electric supply was converted into a profit. The accounts for last year now to be considered will be the last issued over Mr. Street's signature, as he leaves Halifax at the end of this year to take up the post of borough electrical and tramways engineer at Southampton, a position which will give him ample scope for his energies.

During this year considerable extensions of plant have been made at Halifax; that now installed consists of 6,600 H.P. in engines and 4,000 KW. in generators. This includes two 350-KW. extra-high-tension three-phase generators for the long-distance tramways, with rotary converters in sub-stations about eight or nine miles away. There are also three large 750-KW. E.C.C.-Belliss direct-current sets for either lighting or traction; and the whole of the system has now been changed over to continuous current for distribution. The change has resulted in a motor load of nearly 300 H.P.

GENERAL STATEMENT.

	1899.	1900.	Inc.
Total capital expenditure ...	£93,218	£137,884	£44,666
Number of units sold	1,371,333	1,896,667	525,334
No. of lamps connected... ...	45,403	58,770	13,367
Maximum load in KW.	—	1,298	—
Gross revenue	£16,069	£19,207	£3,138
Gross expenditure...	£7,068	£10,163	£3,095
Gross profit	£9,001	£9,044	£43
Average price per unit sold ...	2·77d.	2·39d.	—·38d

The present tariff is 4d. per unit, less 5 per cent. for lighting 2½d. per unit for traction; and 2d. for power. The reduced rates

have had the effect of bringing down the revenue from all sources to under 2½d., but the increase in output of over half a million units has swelled the returns by over £3,100.

The receipts from sales of energy during the past three years were:—

	1898.	1899.	1900.
Public lighting ...	£840	£1,027	£1,167
Private supply ...	£5,538	£7,333	£8,642
Tramway supply ...	£2,332	£7,459	£10,238
	(279,867) units.	(895,094) units.	(1,310,547) units.

Revenue Statement.

	1899. Gross.	1899. Per unit.	1900. Gross.	1900. Per unit.	Inc.
Sale of energy	£15,819	2·77d.	£18,881	2·39d.	−·38d.
Meter rents	140	·03d.	191	·02d.	−·01d.
Sale of old material and installation profits.	29	·00d.	63	·01d.	+·01d.
Sundry fees and rents received.	81	·01d.	72	·01d.	·00d.
Gross revenue ...	**£16,069**	**2·81d.**	**£19,207**	**2·43d.**	**−·38d.**

The gross cost has swallowed most of the increase in revenue. This has been due to augmented figures under the heads of coal and repairs, which raised the works costs by nearly ½d., but owing to economies in other items the total cost is only about $\frac{1}{20}$d. higher than in 1899. The total cost of under $1\frac{3}{10}$d. is still exceptionally good, and is additional evidence of the advantages of combined stations when the output is not very great.

Cost of Production.

	1899. Gross.	1899. Per unit.	1900. Gross.	1900. Per unit.	Inc.
Coal	£3,057	·54d.	£4,678	**·59d.**	+·05d.
Oil, waste, water, and engine room stores.	596	·10d.	634	**·08d.**	−·02d.
Salaries and wages incurred in generation and distribution.	1,147	·20d.	1,632	**·21d.**	+·01d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	369	·06d.	1,137	**·14d.**	+·08d.
Works costs	£5,169	·90d.	£8,081	**1·02d.**	+·12d.
Rent, rates and taxes ..	770	·14d.	842	**·11d.**	−·03d.
Management expenses, salaries of managing engineer, secretary, clerks, &c.	484	·09d.	780	**·10d.**	+·01d.
General establishment charges, stationery and printing, law charges and insurance	476	·08d.	428	**·05d.**	−·03d.
Other expenses: Deputation costs, &c.	169	·03d.	32	**·00d.**	−·03d.
Total costs ...	**£7,068**	**1·24d.**	**£10,163**	**1·28d.**	+·04d.

The increase in gross profit amounted to £43, but financial charges have risen by no less than £1,066, and the difference between these sums, or £1,023, has caused the net profit to be reduced from £5,489 to £4,466. Of this amount £2,000 have again been paid over to the rates, a small sum is allocated to cover the bad debts of 1899, and the balance goes to the renewal fund.

Profit Statement.

	1899.	1900.
Interest on loans, &c.	£2,702	£3,663
Sinking fund for repayments	810	915
Net profit carried to renewal account	3,489	2,340
„ „ to credit of general rate	2,000	2,000
„ „ to previous year's bad debts ..	—	126
Gross profit	£9,001	£9,044

CITY NOTES.

Rand Central Electric Works.

The annual meeting of this company was held on 20th inst. at Winchester House, Sir C. Rivers Wilson presiding.

In moving the adoption of the report, the Chairman said that the 1900 balance-sheet was delayed for obvious reasons, and it had only now been prepared after considerable difficulty. Reconstruction operations are proceeding by day and by night to repair the damage done by Boers. The result shown was somewhat meagre, but, considering all the circumstances, it was matter for congratulation. In spite of all the difficulties and troubles, they had earned enough to pay all working expenses, with a balance over of about £2,000. He paid a tribute to the excellent work done during this trying period by the manager, Mr. Gorrissen. On the debit side of the balance-sheet, the only item calling for notice was £12,023 due to Siemens & Halske. That was a balance of the account which was due to them in respect of the whole of the work of installation. That was the amount due at December 31st, 1900. Since that date the whole of the amount had been paid off, and they stood quits with Messrs. Siemens & Halske. There was some slight augmentation of capital expenditure, amounting altogether to only about £4,000, which was accounted for by their having taken over, at the end of the arrangement with Messrs. Siemens & Halske, certain machines which belonged to them. Coming to the item of sundry debtors £33,387, from which £20,575 was deducted and stated as being in suspense, making a net amount of only £12,812, he explained that they might have technically and possibly a legal claim against their customers to the extent of £33,387 if they pressed them to pay the whole of the minimum amount which they contracted to pay under the contract entered into with the company, but they naturally contended that, inasmuch as during a considerable period of the time of 1900, no current was supplied to them, from causes entirely beyond control, it would be exceedingly unfair if the company were to press for payment for current which had not been supplied to them. Looking at the thing all round, not only from the point of view of equity, but also to the uncertainty of what might be the result of any legal action, he arrived at the conclusion that the company could not properly press the claim. Having stated the worst part of the case, he explained that this £20,000 would really imply no loss, because they had agreed when the mines had met them to that extent, that their contract should be extended to the amount of the period during which no power had been supplied to them, so that if they did not get it in the particular period, to which he was alluding now, they would get it later. That was a compromise which was creditable and satisfactory to both sides. As regards the balance £12,812 standing at December 31st, 1900, about £10,000 had been paid up at the present time. He referred to the undesirability of attempting anything which might appear to be harsh treatment towards their customers, on whom they entirely depended for revenue and profits. As regards all buildings and the administration expenses, they had set aside for depreciation the full amount contemplated in the equipment contract. As regards the machinery, they followed the plan which had been adopted for the last few years, that they should write off an amount in proportion to the absolute work done by the machinery, and not the full amount contemplated in the equipment contract. They had even gone beyond that, for inasmuch as during the period under review the machinery had only really worked up to about one-half of its power, they had set aside one-half for depreciation, and that was a judicious and conservative measure. The profit and loss account worked out at a deficit of £7,452. The deficit arose from the fact of having so very liberally and largely written down for depreciation. There was a saving of something like £1,300 on account of the directors, both in London and on the Rand, having agreed to take half fees during the troubled times. Sir Charles then proceeded at some length to describe the loss they had sustained in the destruction of certain machinery by the Boers. The works were now working about three-fourths of their power. The total expense of replacing the engine machinery is estimated at somewhere between £4,000 and £5,000. The machinery had never been working so well as at the present time, stoppages from what they might call technical causes having only been of about 28 hours' duration. In regard to the question of the charges for supply of power, the equipment contract contemplated a certain tariff, which has been applied up to the present time. The charge was to be of two alternative characters, either the payment for continuous supply at the rate of £45 a year per horse-power, or, as an alternative, a minimum payment of £25, and a sliding scale beyond that minimum charge, beginning at 1½d. for not less than 20 hours. That was supposed to work out at more or less the same result as £45 for continuous supply. Experience had shown that that estimate was too sanguine. They had to consider what their customers might be able to do in producing power for themselves. That became the basis of the calculation of what they should charge. Since the company was brought into operation, circumstances had altered favourably in that direction for the mines. Machinery had become cheaper, coal was more easily supplied and more cheaply, and they must therefore be very careful not to overcharge their customers. They had considered the question of remodelling the tariff upon the basis, not of what might be taken, but upon the basis of the power actually supplied to customers. He was not in a position yet to make any distinct statement as to what that tariff would be.

Mr. G. Von Chauvin seconded the motion, which was adopted.

Aron Electricity Meter, Limited.

The directors' report for the year ending September 30th, 1901, reads:—

The balance to credit of profit and loss for the year ending September 30th, 1901, amounts to £7, 888 1s. 6d. To this is added the amount of £2,963 13s. 2d. carried forward, making a total of £10,851 14s. 8d. The directors propose to deal with the above available sum of £10,851 14s. 8d. as follows:—

£7,493 15 2	for a dividend at 6 per cent. per annum on the preference shares, of which an interim dividend of £3,746 17s. 7d. was paid on April 1st last;
1,212 9 8	to write off cancellation of management contract;
757 15 0	to write off cost of removing to new factory in Berlin;
£9,463 19 10	leaving an amount of
1,387 14 10	to be carried forward to next year.
£10,851 14 8	

The directors ascribe the reduced net profits of the past year and consequent inability to pay a dividend on the ordinary shares, to the prevailing severe depression of trade on the Continent, especially in electrical industries. The meter, in its improved form, is generally gaining favour, and the increased manufacturing resources will enable the company to deal more efficiently with the various demands, and under normal trading conditions, the prospects of the company's business would be satisfactory. The business of the company in

France is now showing signs of improvement, and a French company for the better exploitation of the meter is being formed. The building of a new factory in Schweidnitz, sanctioned by the board at the beginning of the year, is now completed, and the same is ready for the installation of machinery, and when completed, it is anticipated that the cost of production will be greatly reduced. To carry out the above-mentioned extensions and to provide additional working capital, the board have negotiated a debenture issue of £60,000. The details of such issue were at the time communicated to the shareholders. Two directors, Sir James Pender, Bart., and Mr. R. W. Wallace, K.C., retire from office by rotation this year, but being eligible, offer themselves for re-election. Dr. Julius Juttke, a former managing director, has resigned his position, and Mr. S. Barclay Heward, a shareholder, has joined the board. His appointment is required to be confirmed by the meeting. Messrs. Price, Waterhouse & Co. have acted hitherto as auditors, and offer themselves for re-election.

Sir James Pender, Bt., presided on Thursday, last week, at Winchester House, at the meeting of the company, and in moving the adoption of the report, said the result of the third year's working was not as successful as they desired or anticipated, but it might not be an unmixed evil if after a period of 10 or 12 years' progressive and increasing profits in the Aron meter business they should once have the unpleasant experience of a relapse. It would certainly have the effect of making them extra careful in the coming year in husbanding and economising their resources in every respect, without detriment to the legitimate expansion of their business, which was intended. After the most satisfactory result of the previous year's working, the directors felt justified in making the necessary arrangements for increasing the output of the company. New premises were taken in Berlin, where from the original small factory they moved into a modern new and extensive factory in Charlottenburg. A similar process they experienced in London, where from their small assembling shop in Upper Thames Street they moved into a spacious building in Union Street, Borough, where they could carry on work suitable for their requirements. The cost of these removals was visible in their books, and was considerably over £1,000, but apart from the expenses incurred, there was in the removal of a factory constantly taking place an invisible loss occasioned by the temporary disorganisation of a factory during the time of its establishment. Everybody who had gone through this experience would know that the efficiency of any works during the transition period usually resulted in a small output at the same or a larger expense, and no forethought could ever prevent this. For this reason the directors rather expected in the first year of this transmission a slight relapse on this account, with a possibility of equalising it by increased sales. But they had had to contend during the past year with an evil far more important. The industrial *débâcle*, which had been in evidence all over the Continent during the second half of their financial year, hit them in many ways in almost every country on the Continent. In Germany, in Austria, in France their business decreased, not on account of the quality or price of the meter, but on account of the financial depression. Meters in those countries were ordered, not so much on behalf of the municipalities, as in Great Britain, but mostly by companies holding concessions in those countries. These companies suffered in the past year of financial embarrassment, which affected them in three ways: the companies either abstained from ordering altogether, or some of them, who could order, had to be met with a tactful reticence, so as to guard against possible losses, while the few exceptional concerns that were not depleted of funds limited their orders to a minimum, and naturally at the closest price. Great credit was due to the foresight and care of Prof. Aron for preventing losses by bad debts on the Continent. Those who know the condition of affairs abroad would bear him out in this, that such a small sum of £1,200 only should be required as provision for bad debts to cover the risk for the whole year could not be considered unsatisfactory; the auditors were quite satisfied that this provision was ample. On the other hand, it was a point of safety after all not to have all their eggs in one basket, by doing business in this country and on the European Continent, but this year this reacted against them, as they were not suffering from the business they had done here, but from the effects of the business abroad. The directors felt that once things look brighter again, the normal state of affairs in the company would be easily re-established. The directors had continued to do their best for the exploitation of the meter during the past year wherever possible. For this reason they were on the point of forming a separate company in France, so as to give themselves a better standing there. Their company would hold all the shares in the French company. A similar arrangement existed in Germany, and was found to work satisfactorily. The American company, they hoped, would in a short time start manufacturing; they had sent some of their staff out to the United States to give the Americans the advantage of their experience. They expected the American company would be successful, and this would have a very pleasing material effect on the shares they held in that company. The meter had been improved under the most careful supervision by Prof. Aron, and slowly, but surely, they were wiping out some of those defects which develop in a sensitive measuring instrument while in practical use. The competition in the meter continued keen, but, quality for quality, they thought they were well able to compete. They had achieved one notable success on the Continent, where their patents for multiphase meters had been infringed. Litigation was started, which terminated in their favour, and three of the most powerful companies on the Continent were now paying them a satisfactory royalty on all meters of their type which they manufactured, and which fell under these patents. Only a small amount of these royalties was included in the present balance-sheet, for they only fell due at the end of the year. For the purposes of the extensions to which the board pledged themselves after last year's success, it was necessary to find additional working capital, and they had been able to negotiate a debenture issue at what they were advised were most favourable terms. As the payment of this debenture money was spread over a period of seven months, there appeared among the assets of the present balance-sheet in cash only a little more than half of the proceeds of the issue. The board much regretted the retirement of one of their number, Dr. Juttke, who previous to his appointment as a managing director was for many years in the business with Prof. Aron, but his views and those of Prof. Aron as regarded the conduct of the business on many points were so opposite, that in order to secure the absolute and hearty co-operation and assistance of Prof. Aron the directors decided to accept Dr. Juttke's resignation early this year under an agreement, which is alluded to in the balance-sheet. They secured the co-operation of Mr. S. Barclay Heward, a shareholder in the company since its inception and a gentleman of considerable business experience in the City of London. The profit available had been divided, he hoped, with approval, in giving 6 per cent. to the preference shareholders. He hoped the ordinary shareholders would find that the directors tried to serve the best interests of the company in using the surplus earnings over and above the amount required for the preference dividend for the purpose of writing off the various items in lieu of keeping them hanging over. This would enable the company to start with a cleaner sheet this year, and the ordinary shareholders would, they trusted, reap the benefit next year.

Mr. Hugo Hirst seconded the motion, and while deploring the unsatisfactory result of the year's working, assured the shareholders that the meter was all right, and was now as perfect as could be. He was glad to say things were improving on the Continent, and they had had a great advance on orders for the Continent on the past few weeks. He might tell them they had recently designed and perfected a new time switch, for which they had already received hundreds of orders. They had great hopes of this invention, and believed it would be the source of additional income.

A number of criticisms by various shareholders was answered by the auditor, who said he thought the courts would not allow goodwill to be written down if a number of shareholders objected. The American shares stood as part of the goodwill, and it was impossible to say what their value was at present.

Mr. Wallace, K.C. (a director), said that on joining the company he went into the matter of goodwill and he felt that seeing the business done and the scope for development, the goodwill was not too much, although they paid the full value for it. The reason of the depression in Germany was, he believed, the over-development of the electric traction industry. The same people were interested in both traction and lighting, and when the crisis came the directors had to consider whether they should supply firms whose stability was not assured, and he thought they had done a wise thing in shutting down the German business to a large extent. If their business did not warrant the original price paid, they would have to write down the goodwill. What he thought the board had to look into was as to whether Prof. Aron was competent to manage the commercial as well as the technical part of the business.

The report was adopted.

Stock Exchange Notices.—Applications have been made to the Committee to appoint a special settling day in—Calcutta Electric Supply Corporation, Limited—Further issue of 10,000 shares of £5 each.

Eastern Extension, Australasia and China Telegraph Company.—The directors have declared an interim dividend for the quarter ended September 30th last of 2s. 6d. per share.

Eastern Telegraph Company.—An interim dividend of 1½ per cent. on the ordinary stock, tax free, in respect of profits for the quarter ended September 30th, is announced.

TRAFFIC RECEIPTS.

Bristol Tramways and Carriage Company.—The receipts for the week ending December 20th were £3,854; corresponding period last year, £3,802; increase, £52.

British Electric Traction Company.—The following returns are issued of the undertakings of this company for the week ending December 13th:—

Company.	Amount £	Comparison with corresponding week of last year. + £	Comparison with corresponding week of last year. — £	No. of weeks.	Aggregate. Amount. £	Aggregate. Inc. or Dec. + £	Aggregate. Inc. or Dec. — £
Croydon*	459	203	—	50	16,876	2,219	—
Devonport	361	—	—	25	9,851	—	—
Dudley—Stourbridge	530	—	38	50	32,740	16,010	—
Gateshead	610	—	—	31½	18,593	—	—
Greenock-Pt. Glasgow	368	—	—	10	2,832	—	—
Hartlepool	160	—	26	50	11,197	1,266	—
Kidderminster ..	92	4	—	50	6,024	640	—
Merthyr	177	—	—	86	8,914	—	—
Oldham—Ashton ..	447	—	6	50	24,781	3,134	—
Poole	158	—	—	96	10,054	—	—
Potteries	1,400	173	—	50	69,899	19,692	—
Southport†	101	—	10	50	8,045	—	2,804
South Staffordshire‡	691	—	26	50	38,578	2,445	—
Swansea	397	19	—	50	21,889	4,294	—
Taunton	53	—	—	16½	1,315	—	—
Tynemouth	163	—	—	38	10,390	—	—
Wolverhampton Dist.	63	15	—	50	3,293	772	—

* Partly horse. † Reconstructing. ‡ Partly steam.

City and South London Railway.—The receipts for the week ending Dec. 22nd were £3,242; corresponding week last year, £1,920; increase, £1,322. Total from July 1st to date, £55,570; corresponding period last year, £41,569; increase, £14,001. Miles open, 6½; corresponding period last year, 4½.

THE DESTRUCTIVE AND LETHAL EFFECTS OF HIGH-PRESSURE * CURRENTS. †

By Dr. MARGARET A. CLEAVES.

(*Continued from page* 953.)

In reviewing the work of the different experimenters in sequence, it is found that D'Arsonval concluded from his observations of the phenomena which took place in animals subject to lethal doses of electricity, that death occurred in two ways:

1. By lesion or destruction of the tissues (disruptive and electrolytic effects of the discharge).

2. By excitement of the nerve centres, producing the arrest of respiration and syncope, but without material injuries. In the first instance death is absolute and final, but in the second he believed that the nerve centres—respiratory—were inhibited, which gave rise to a suspension of respiration and arrest of heart action. In his estimation the primary action was upon the respiratory function, and the cardiac failure followed upon exhaustion of the medulla oblongata and functional death of the ganglionic cells. The fact of cardiac action after arrest of respiration led to this theory.

3. Tatum concluded that the essential fatal field of action lay within the substance of the heart itself; that the external inhibitory mechanism played little or no part; that electrical currents finally arrest respiration without simultaneous or still earlier arrest of the heart; and that no changes were observable in the substances or functions of the muscles and nerves or blood which could in any sense be the cause of sudden death. He offered no explanation as to the nature of the action on the heart, but, from experiments with curare and atropine, he believed that the action was a direct one upon the muscular tissue rather than one involving any nervous mechanism. He had no suggestion to offer as to why the heart muscle was more susceptible than other muscles, but hoped that a more special study of the subject would soon be possible. That hope has been fulfilled in the work of Prévost and Batteli and in that of Cunningham.

4. The experiments of Houston and Kennelly have already been referred to as of interest, not from the physiological side, but in demonstrating that death is practically instantaneous and painless from the purposed and scientific applications of high-pressure currents. They showed, as Tatum had—and this has been confirmed by later investigators—the tolerance of an animal to currents of high pressure when passed through the head (contacts consisted of cotton pads well wetted with saline solution and placed in the ears of a dog; alternating currents of 700 volts, 690 of which were effective; resistance, 1,200 ohms; current, 6 amperes; duration, five seconds; loss of consciousness, but animal not killed). Their conclusions as to instantaneity and painlessness of death will be considered later on.

5. Bokenham and Jones confirmed the observations of Houston and Kennelly, that a much stronger current was required to kill an animal (the experiments were made upon cats) when passed through the head or when the contacts were placed on either side of the neck. The pulse tracings taken by Bokenham and Jones, and careful inspection of the respiratory movements, led them to conclude that death was caused by failure of the heart, and the negative results of shocks of equal strength passed through the head and neck strongly suggested to them that the action was upon the heart muscle directly rather than through the nervous mechanism.

6. Bleile, after a series of very carefully conducted experiments, eliminated during their progress (1) the direct action of the current upon the heart, by artificial respiration; and (2) the influence of the pneumogastric nerve, by the hypodermic injection of atropine, thus paralysing the nerve fibres. He also, (3) prior to the application of the current, administered nitroglycerin and nitrite of amyl to produce dilatation of the arterial system. He then concluded that death was due to contraction of the arteries, through the influence of the nervous system, and that the constriction of the arteries furnished a greater mechanical impediment to the flow of blood than the heart was able to overcome.

7. Kratter concluded from his experiments that the first effect consisted in a permanent arrest of the respiration, and he regarded death from an electric shock as a form of suffocation.

8. Oliver and Bolam concluded that the action was upon the heart muscle rather than upon any of its nervous mechanisms. They observed that when the current ceased to pass, the heart underwent distention and then entered into a state of *fibrillary tremor*, maintained for a variable period, while the animal would make deep, respiratory efforts—shown by forcible movements of the diaphragm. They failed, however, to interpret the value of this phenomenon, although they were the first to record it in connection with experiments made to determine the mechanism of death.

The analysis of the work of the physiologists thus far recorded points with three exceptions to a direct action on the heart as the cause of death. But it remained for Prévost and Battelli and Cunningham to show how the current acted on the heart muscle. Their experiments seem to have been conducted simultaneously and without knowledge on the part of either one as to what the other was doing—as is so often the case when scientific investigation of any sort has been carried to a certain definite conclusion—but the priority of publication belongs to Prévost and Battelli (*Comptes Rendus de l'Académie des Sciences*, March 13th and 27th, 1899; *Jour. de Phys. et de Pathol. Générale*, May and September, 1899—et *Revue Médic. de la Suisse Romande*, September, 1899; R. H. Cunningham, N.Y., *Med. Jour.*, October 21st, 28th, 1899.*

The experiments of Prévost and Battelli are no more conclusive as to the action of a lethal dose, but are more complete in that they deal both with continuous and with alternating currents of varying pressures, thereby establishing very clearly the apparent discrepancies in the action of low and high pressure currents. The experiments of Cunningham, on the other hand, were made with continuous currents only, at pressures of 115 volts (lighting mains) and 124 volts (battery of accumulators).†

Prévost and Battelli determined from their observations that the mechanism of death from both continuous and alternating currents was the same, although the action varied in a slight degree.

From their researches they find that death by electric currents takes place in two ways entirely different the one from the other.

1. By the action of a low pressure current, death in man is due to the primary paralysis of the heart in *ventricular tremulation*. This is regarded as the usual cause of death in accidents of the electrical industries, because, as has been pointed out, the conditions of the conducting circuit are such that a high pressure current acts as a low pressure current.

2. A high pressure current, when the contacts are good and the heart lies upon the line which unites the electrodes—*i.e.*, in the conducting path—does not paralyse the heart of man. In this case the respiration has been resumed, as has been noted at the earlier electrocutions in New York State.

When death takes place, under the conditions just mentioned, it is due to an inhibition of the respiratory centre. The heart continues to beat with energy and stops only after the asphyxia. It is in these cases that it is sufficient, as a rule, to practise artificial respiration.

The paralysis which occurred in animals the subject of experiment, through the action of a low pressure current, *i.e.*, 120 volts, they found "analogous to that which is directly obtained from exciting the exposed heart with an induced current, *fibrillary tremulations* of the ventricles, while the auricles continued to beat. This is the well-known phenomenon designated by physiologists as *ventricular tremulations* or *fibrillar contraction*."

A. The following phenomena were observed by them in their experiments upon dogs, cats, guinea-pigs, rabbits, and rats:—

Alternating Currents.—"1. Instantaneous paralysis of vagus and of cervical sympathetic with currents of high pressure.

"2. Non-modification of phenomena described above by previous section of vagus nerves.

"3. The repletion of the heart with blood, even in the case of currents of high pressure and short duration, which seems to prove that the vascular tone and vaso-motor centres are not paralysed.

"4. No appreciable elevation of the temperature, if the time of the passage of the current is not prolonged.

"5. Rapid appearance of cadaveric rigidity in the case of the currents of high voltage.

"6. At autopsy, absence of constant and characteristic microscopic lesions. Notwithstanding, one finds sometimes hyperæmia of the meninges, but not intracerebral hæmorrhages, if the subject of the experiment has not been subjected to elevation of the temperature.

"7. *Duration* of the contact is important; respiration, *cæteris paribus*, is more affected when contact has been longer. Convulsions and general tetanus will be more pronounced if the contact has been short. The more the voltage is raised, the shorter is the duration of the contact necessary to cause convulsions.

"8. The *points of application* of the electrodes are a matter of great importance; their differing position can vary the appearance of this or that symptom.

"*Respiration* will be affected more easily, and convulsions more easily produced, if one of the electrodes is placed upon the head.

"*Heart*—The voltage necessary to produce the *fibrillary tremor* is less if the heart is in the line between the poles. Inversely, if the heart is not in this line, it can be thrown into *fibrillary tremor* (*tremulations fibrillaries*) upon the application of currents of high pressure, which, in traversing the heart directly, would not have paralysed it.

"9. When, after currents of high pressure, the heart of the dog or of guinea-pig is paralysed consecutively to the arrest of respiration, *massage* of the heart provokes the *tremulations fibrillaries*, which are wanting in a case of simple asphyxia not produced by electrocution."

B. *Continuous Currents.*—Conclusions reached:—

"1. *Respiration* and *sensibility* react the same to the shocks of closure or of opening.

"2. *Convulsions*, on the other hand, are especially provoked by opening of the current.

"3. As to the *heart*, the fibrillary tremor will come on if the circuit be not closed or opened abruptly. It is a fact, analogous to that which was stated with regard to alternating currents, that a violent excitation can make the fibrillary tremor cease.

"4. Examination of the tracings of arterial pressure seems to

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* In every instance in which authorities quoted have used the word "tension" in relation to an electric current, the writer has substituted "pressure," in order that the terminology may be exact.

† *Handbook of the Medical Sciences. (U.S.A.)*

* Cunningham's article was completed toward the end of February, 1899, but was held back until March 31st, when it passed into the hands of one of the Prize Committees of the College of Physicians and Surgeons, New York, where it remained until published.

† Cunningham made some experiments in 1894 with currents of a higher pressure, but the detailed results are not embodied in his paper of October 21st and 28th, 1899.

indicate the absence of a vaso-motor excitation, which, on the other hand, is produced by the alternating currents."

The fact that in some of the earlier electrocutions in New York (McElwaine, Jaylor) respiration was not definitely arrested when the body was traversed by a pressure of 1,700 volts alternating current (contacts good, head to leg, continued for several seconds), is in a line with some of the experiments of Prévost and Battelli. For example, a large-sized dog was submitted to the action of an alternating current of 4,800 volts (contacts good, duration several seconds), and yet spontaneous recovery of the respiration took place. On the other hand, in their experiments with a much lower pressure (240 to 600 volts, as well as with those of H. and K.), death was absolute. They found in dogs that these currents of medium pressure produced not only paralysis in ventricular tremulations of the heart, but also absolute arrest of the respiration. In such cases instantaneous death would result from the inhibition of the nerve centres, seconded by the failure of the circulation. In the first instance a repetition of the shock is sufficient to produce a definite arrest of the respiration; and while physiologically death cannot be regarded as strictly instantaneous, it is practically so, so far as consciousness is concerned.

In view of the unquestioned fact that currents of the same degree of pressure and applied under apparently the same conditions, both in man (electrocutions) and in animals, produce such different results—lethal in the one case, and non-lethal in the other—we are justified in concluding that there must be differences in vital resistance. It is very evident from all the evidence forthcoming that the human respiratory system offers a very great resistance to an electric shock, and this resistance is by no means the same in all individuals, just as experiment has shown that it is not so in all animals. The fact that the nervous system is of a higher organisation in man than in animals is suggested by Prévost and Battelli as a reason why the function of the respiratory centre should be abolished in the former with but a slight increase of voltage. This is not substantiated, however, by the results of electrocution. Prévost and Battelli show by their experiments upon animals that, all other things being equal, the higher the pressure the greater the certainty of the definite abolishment of the respiratory function, and they place the pressure necessary for the purpose beyond 1,700 volts.

So far as the evidence is at hand from the electrocutions which have taken place in New York—some 50 in number—it appears that the expenditure of this tremendous energy varies in its action in different individuals; that while in one a complete inhibition of the respiratory centre from a single application results, in another several successive shocks are required completely to abolish its function; and again, in other instances, there seems to be an actual mechanical disruption (24th electrocution), as the blood from every peripheral as well as from the larger vessels is forced by the powerful tetanic, muscular contractions into the chest and head, with rupture of some of the blood vessels. It is fair to suppose that nearly all the energy liberated in the body is expended as heat; and, as a matter of fact, there is a considerable rise in the temperature, although the action of this heat does not bring about death. In this connection it is interesting to note that Prévost and Battelli found that there was no intracerebral hemorrhage when the temperature was not raised, which would seem to indicate a definite relation between the amount of energy liberated and the result.

If this energy acted to produce either inhibition of the respiratory centre or paralysis of the heart in ventricular tremulation, there might not be an appreciable rise in the temperature; but when it has acted to produce a disruptive effect, as, for example, in some accidents from industrial currents and sometimes in electrocution (*i.e.*, with excessive intracerebral hemorrhage and rupture of some of the blood vessels), the evidence shows that the rise is considerable.*

Analysis of the accidents from industrial currents (presented farther on in tabulated form) would seem to confirm the experiments of Prévost and Battelli in reference to the action of the current on the respiratory centre.

In cases 2, 3, 8 and 10, there was contact with alternating pressures of 2,000, 4,500, 10,000, and 25,000 volts respectively, followed by recovery. From the conditions of the conducting circuit (*i.e.*, position and nature of contact) No. 2 was evidently a hand-to-hand contact; No. 3, bipolar, *i.e.*, telephone wire grasped in hand, which touched another wire; No. 8 a hand-to-hand contact; and No. 10 a hand-to-hand contact (the energy was not expended upon the respiratory centre in such a way as definitely to arrest respiration, nor was the heart in the direct conducting path). To produce inhibition of the respiratory centre, a head-to-spine contact is the most favourable, although a head-to-leg contact contributes to the same result. The latter position of contacts also favours action upon the heart primarily, although a chest-to-spine, or to spine-and-head, is better. Had the latter condition obtained in No. 10, on account of the very high resistance offered by the position and nature of the contact, the pressure, although high, might have acted as a low-pressure current to paralyse the heart in ventricular tremulations.

The data in cases Nos. 1, 9, 11, 12, 13, 15, 16 and 20 seem corroborative of the experimental work of Prévost and Battelli, showing that high-pressure currents, by reason of high resistance, act as low-pressure currents. Although the pressure in every one of these instances was high, the inference is reached, from instantaneous death, that they acted by reason of position and nature of contact as low-pressure currents, and that death was due to paralysis of the heart in ventricular tremulation. Unfortunately, there has never been any opportunity of observing this phenomenon in man, and the inference can be drawn only by the action on warm-blooded animals. By reason of the fact that in the industries the contacts are always bad, both as to position and as to nature, the resistance great and amperage small, the effect produced is that of a low-pressure current. This effect is more grave when the initial pressure is high—less so with a diminution of voltage.

It is not believed by Prévost and Battelli that the paralysis of the heart in man is always permanent, but that it may sometimes be transitory. This conclusion is reached by them as the result of an analysis of some accidents, and from the fact that the current does not affect all animals similarly; that in some—for example, a guinea-pig—the heart rarely resumes its beats, but that in the rabbit it often resumes its rhythm. These are inexplicable facts, and we have no means of knowing that the human heart may not comport itself similarly.

(To be continued.)

* D'Arsonval and Brown-Séquard regarded the rise in temperature in part as the result of the asphyxia.

CURRENT SPECIFICATIONS.

LXXXV.—BARNSTAPLE ELECTRIC LIGHTING.

Summary.

Extent of Contract.—Supply and erection of plant necessary for a complete electric lighting scheme.

Proposed System.—Three-wire direct current scheme with accumulators arranged for a voltage between middle and outer conductors at consumer's lamp terminals of 230 volts.

Boilers.—Three to be supplied, each capable of evaporating 5,000 lbs. of water per hour, with natural draught, chimney 80 ft. high, and good Welsh coal.

Type.—To be either straight water-tube or "Economic" type, suitable for a pressure of 160 lbs. per sq. in.

Superheaters.—To be fitted to each boiler, suitable for heating steam up to 500° F.

Fuel Economiser.—One to be provided suitable for heating 1,000 gallons of water per hour from 100° F. to 212° F., the temperature of gases being 600° F.

Tank.—To be provided, to hold 5,000 gallons.

Condensers.—Three No. 7 Ledward's ejector condensers to be provided and fixed.

Boiler Feed Pump.—One Hall compound feed pump to be provided and fixed, capable of delivering 1,800 gallons per hour against a pressure of 160 lbs. per sq. in.

Engines.—Three to be provided, of high-speed compound enclosed type, each capable of easily driving a 125-kw. dynamo at full load, at speed not exceeding 400 revolutions per minute, with 135 lbs. per sq. in. steam pressure.

Range of Governing.—Not to exceed 2½ per cent. when whole load suddenly thrown off.

Steam Consumption.—Best guarantees at full, three-quarter, half, and quarter loads B.H.P. to be stated.

Dynamos.—To be of standard type, capable of developing 125 kw. at 500 volts at normal speed of engine. To be used usually as shunt, but also to be fitted with series field coils and switch.

Permissible Temperature Rise.—65° F. above surrounding atmosphere after six hours' full load run.

Efficiency.—Not to be less than 93 per cent. at full load.

Balancer and Booster.—To consist of four machines, two balancers, each to deal with an out-of-balance current of 100 amperes on 250-volt three-wire circuit, and two boosters, each to raise voltage of 60 ampere current 110 volts. Speed of set not to exceed 1,000 revolutions per minute.

Centrifugal Pump.—One electrically-driven centrifugal pump to be provided to deliver 25,000 gallons of water per minute against 23-ft. head.

Switchboard.—Of standard type to be supplied, arranged for three dynamos, nine circuits, battery of accumulators, and motor balancer and booster.

Public Lighting.—Five arc lamps, 20 posts, each with fittings for two 25-c.p. lamps, and 39 brackets with fittings for one 50-c.p. lamp.

Meters.—Two years' supply at scheduled prices. Sizes from 2½ to 80 amperes. Two-wire, 230 volts.

Accumulators.—Battery to give terminal voltage of 500 volts at end of nine hours' discharge at 48 amperes. Emergency discharge, 200 amperes for one hour.

Travelling Crane.—Hand travelling crane, suited for a span of 33 ft. and a normal working load of 5 tons.

Artesian Well.—To be bored where directed. Electrically-driven three-throw pump to raise 3,000 gallons per hour, total lift being taken at 20 ft.

Specified Dates of Completion.—Crane in four months, well and street work in five months, rest of plant in six months from date of signing the contract.

Penalty for Late Completion.—One per cent. per week of contract price for each section.

Stipulations as to Removal of Foreman.—Satisfactory.

Stipulations as to Wages Paid to Workmen.—None.

Specified Terms of Payment.—80 per cent. by monthly payments on engineer's certificate as work progresses, 10 per cent. on completion, 10 per cent. at end of 12 months' period of maintenance.

Arbitration Proposals.—Satisfactory.

Date for Receipt of Tenders.—January 16th, 1902.

This specification has been prepared by Mr. W. H. Trentham, M.I.E.E., the consulting electrical engineer to the Corporation.

From the summary given above, it will be noted that the plant asked for follows the usual lines for a three-wire direct current station. Each of the three 125-kw. generating sets is specified to be wound for 500 volts, the cells and motor balancer being depended upon to give the necessary balancing power to the system.

There is little of special interest in the technical portion of the specification, except in the case of auxiliary apparatus; the requirements are simply stated, and the tenderer is left free to offer what he considers will best meet the requirements of the case.

The general conditions are, on the whole, of an acceptable character. We note that with reference to the penalty clause the fine for late completion of 1 per cent. per week is only to be inflicted on the contract sum for each section late, although a number of sections may be placed in the hands of one contractor. We consider this a very fair proposal, for, as often pointed out, to demand 1 per cent. per week of the *total* contract price often imposes exceptional risk upon a contractor securing the order for the whole of the work.

The terms of payment are thoroughly satisfactory, 80 per cent. on monthly certificates while work is in progress, 10 per cent. on completion, and 10 per cent. at the end of the 12 months' period of maintenance against defective workmanship and material, while the arbitration clause is also unlimited in operation.

HENDON AND THE LOCAL GOVERNMENT BOARD.

The history of Hendon in connection with electric lighting schemes is interesting and instructive.

The district is one that does not lend itself kindly to an ordinary system of supply from local works. It is scattered and sparsely populated, the only dense centres being those occupied by the working classes, where cottages containing two flats to accommodate separate families prevail.

So scattered are the dwellings, that when a provisional order was granted, two compulsory areas were scheduled, one to be completed within two years, and the second a year later, while a third is now to be added as an inducement to the Governors of Mill Hill School to withdraw their opposition to the scheme of the Urban District Council, the supply in this area to be simultaneous with that in the others, at an extra cost of £5,910, raising the loan to £42,300.

A Local Government Board inquiry into the application of the local authority for a loan of £36,400 was held on 7th and 12th inst., which provoked an unusual amount of opposition, and presented some knotty points for consideration by the department, whose inspector, Colonel A. J. Hepper, D.S.O., R.E., conducted the proceedings.

Before going into the statements and evidence submitted to the inspector, it will be useful to recapitulate the requirements of the Local Government Board with reference to these inquiries. The following is the text of the document issued from the department, and if the data asked for are supplied, the inspector is able to report upon three essentials, viz.:—

1. The financial position of the town.
2. The engineer's estimates of cost of plant and working.
3. The actual demand for current.

Requirements of the Local Government Board.

1. A copy of the electric lighting order.
2. A general plan showing the position of all the proposed works, the distribution of the wires and the limits of the district to be lighted by the installation.
3. Information as to the type of generator to be used, the power of the engine (steam or gas) to be erected, the method to be adopted for dividing the current, and the kind of lamp to be used.
4. A detailed estimate of the cost of the different works.
5. Copy of the resolution of the Town Council authorising the application referred to.
6. Financial particulars as to the assessable value and existing debt of the borough. Also an estimate showing the expected revenue from the supply of energy as ascertained by communication with intending consumers, whose premises and requirements should be specified in the estimate, with evidence that the approval of the Board of Trade had been obtained to the system proposed to be adopted.

We gather from the opening statement of Mr. Bartley Dennis, who represented the Urban District Council, that during the last 10 years—in fact, from 1888—the local authority had "simply been overrun by companies" anxious to introduce the electric light, but the cautious councillors had opposed them all, although the ratepayers had been steadily abusing them for keeping out the light.

This benevolent action of the Council in protecting the pockets of rash speculators, is a new explanation of the opposition to electric light companies, and will hardly satisfy lookers-on who see in the course adopted the "dog in the manger" policy, which prevented companies doing that which the local authority were not prepared to undertake themselves.

The irony of the position was established in the summer of 1898, when the Electrical and General Engineering Company applied for powers. The Council refused assent on the ground that the district was not ripe for such an undertaking, and that when it was they would themselves apply for the powers. The company persevered with their application and induced the Board of Trade to hold a local inquiry, at which the Council came to terms with the company and became the undertakers under the Order. In 1899 Mr. Hammond was appointed consulting engineer, and he then advised the Council that it was a matter open to doubt whether such a scheme would be self-supporting, and that the experiment would be watched by all the district councils in the kingdom.

The evidence in support of the application was rather curious. Mr. Hammond said that the Council had not canvassed the district with a view to finding the number of probable customers, and only two witnesses were examined on the point. Mr. Bousfield, K.C., M.P., wanted the light for his own house, and thought, in the course of five or six years, it could prove a good investment; he admitted that if the majority did not want the light, he thought the majority should rule.

The vicar of the parish practically proved nothing as to the probable demand, but said that, assuming the undertaking would pay, it was very much better that the profits should go to the relief of the rates than into the hands of a company. *He was not prepared to say that the district was quite ripe for the scheme.*

Thus no evidence was forthcoming of demand, and against the overwhelming testimony of the ratepayers in opposition to the speculation, it is hardly conceivable that the Local Government Board will sanction such an undertaking.

It appears to be an enterprise in which municipal trading is altogether unjustifiable, and especially as it appeared, by the evidence, that the supply of the town could be obtained upon cheaper terms to the consumers, and without risk to the ratepayers, under the comprehensive scheme of the power company possessing Parliamentary powers to run mains through the district.

To prove demand, the advocate for the Council adopted the singular course of arguing that the petition presented to the Board of Trade in 1898, in favour of a company undertaking the supply, was proof of a present demand, although a large number of the signatories were now opposing the scheme of the Council.

The opposition on the present occasion appears to have been of a most comprehensive character, including 265 owners and ratepayers in the compulsory area, out of a total of 630 houses in all, of which 201 are cottages rated under £25, 291 under £50, 102 under £100, and 36 over £100.

Opposition was also made by a body of 359 ratepayers outside the compulsory areas, the Hendon Provident Club numbering 180, 63 tenants on the Schweppes' estate, the Midland Railway Company, who pay one-eighth of the rates, besides the gas company, and several ratepayers opposing in person. The case for the gas company, who can scarcely rank as disinterested, was that the undertaking could not pay, and they objected to the scheme as ratepayers; it appeared that as the total takings for gas only amounted to £3,000, it was not likely that Mr. Hammond's estimate of a revenue of £4,250 from the compulsory area only could possibly be realised.

Some of the utterances of the inspector, as reported, must have been encouraging to the promoters of the speculation, although it is hardly to be supposed that he intended them to indicate opinions which could only be matured after all the evidence in the case had been submitted; thus, on the question of a probable loss resulting on the undertaking, he interpolated the remark: "Companies seem ready to take it up;" and again, on the evidence that a company could supply cheaper than under the proposed scheme, the inspector said that *even if the Council could get it cheaper from a company they had the discretion of making it themselves*—and again—"*it ought to be much cheaper, to upset the position of the Council.*"

Abundant evidence appears to have been given that, except in the increase in houses to accommodate the working classes connected with Schweppes' factory, the Midland Railway, &c., the town was stagnant—no demand for building land, and difficulty in letting houses, except the small cottages.

The arrangement made with the Mill Hill School necessarily alters all the calculations as to the results of trading, interest, sinking fund and depreciation, upon an additional outlay of £5,910 having to be provided for against the revenue from the school, which is the only demand assured, the ratepayers generally at Mill Hill being opponents of the undertaking.

Mr. Hammond, who, like the Gas Company, can scarcely rank as a disinterested witness, appeared in a new *rôle*, as offering to personally guarantee the interest and sinking fund for 10 years, but added subsequently: "I will sign a guarantee *on terms*, of course."

It would be interesting to know the terms, as the local authority might be glad to insure against the risk of loss, if the premium were not too high.

The result of the inquiry will be awaited with curiosity, for if the loan be granted without the evidence of demand being proved in accordance with the requirements of the Local Government Board, that document should be officially explained.

Hendon is a doubtful field for an experiment in municipal trading in electricity supply, as Mr. Hammond admitted there was not another Hendon; it certainly compares unfavourably with Canterbury, where the surplus was only £14 on the last year's trading, with no provision for depreciation. The neighbouring town of Harrow, worked by a company with no sinking fund to provide, can only pay 3½ per cent. dividend for the third year's trading, after setting aside £450 for depreciation on a capital expenditure of £43,017, and £521 interest on loans. The cost of generating and distributing the current, including management, was 4·23d. per unit, against the estimate of 2½d. for Hendon. Comparisons, we know, are odious, but Harrow is a better guide in this case than Canterbury.

At the inquiry at Hendon, Mr. Hammond asserted that *if all the ratepayers were against the scheme, he would advise the Council to proceed.* If this be the policy of the Local Government Board, a local inquiry is a farce; but we should much doubt if such views can be endorsed by any responsible Government department.

ALUMINIUM.

Two papers dealing with matters connected with aluminium have been communicated to the Institution of Electrical Engineers recently; the first, by Mr. E. Wilson, entitled "The Physical Properties of Certain Aluminium Alloys, and Some Notes on Aluminium Conductors," was read in London on November 28th; the second, by Mr. W. M. Morrison, of Foyers, entitled "Aluminium: Notes on its Production, Properties, and Use," was read before the Glasgow Local Section on December 10th. Lack of space preventing us from printing these papers *in extenso*, we give an abstract herewith; and, for convenience, take the second first.

Much of Mr. Morrison's communication travels over ground familiar to the aluminium student. He describes the Foyers factory with its seven Girard turbines driving each its own Oerlikon dynamo of 700 E.H.P. at 150 revolutions per minute; and he mentions that the entire plant runs with a load factor, allowing for stoppages, spare power, &c., of from 0·90 to 0·95. There are also two Pelton wheels driving two Parker dynamos which furnish light to the works and some neighbouring houses, as well as power to numerous motors. The main dynamos are hand governed, and can be stopped down in three minutes without straining the pipe line. The smaller turbines are fitted with hydraulic relay governors. The artificially enlarged loch impounds enough water to run the machinery for 50 days and nights without rainfall; the water tunnel is 8 ft. 6 in. in diameter; the effective head of water is 350 ft. No waste products pass into the water, which escapes into Loch Ness perfectly pure. In theory, the Héroult process is beautifully simple and perfect, but practically it demands great care, as innumerable difficulties are constantly experienced which have to be guarded against, and, if possible, anticipated. At the moment the process is without a rival; but should an easy and inexpensive method of producing aluminium sulphide be discovered, "which is certainly within the range of possibility," the effect on the cost of winning aluminium may be considerable. Electrolysis now takes place in a bath of alumina dissolved in molten cryolite; and as the specific gravity of that bath (saturated with aluminium oxide) is 2·35, while the density of molten aluminium is only 2·54, there is a very small margin of weight to cause the metal to sink to the bottom of the cell. The lowest price at which steam power is ever offered is, in Mr. Morrison's belief, £8 per E.H.P. year of 365×24 hours, whereas electrical power from water delivered on the consumer's switchboard is sold at £4 by companies apparently making a handsome profit. Thus water seems to have a monopoly. On the contrary waterfalls are generally in more or less inaccessible positions; but since in most electro-metallurgical work the cost of power is the most serious factor, the inaccessibility is balanced by the economy of the power. It remains to be seen whether gas engines, "which depend for their cheapness on the sale of a by-product for which there is a doubtful market," will rival water as a source of industrial energy.

The world's output of aluminium is now over 5,000 tons per annum, but as 497,000 tons of copper and 79,200 tons of tin are being consumed every year, the quantity of aluminium manufactured is only 0·87 per cent. by weight or 2·85 per cent. by volume of these combined figures. Aluminium has suffered commercially by being too highly recommended for some purposes and too little advocated for others. It is so light that, for equal volumes, it weighs only 37 per cent. of zinc—the next lightest industrial metal; and only zinc, lead, and iron are cheaper on this basis of comparison. Zinc and lead castings both shrink 0·3125 in. in a foot, or 2·60 per cent., whereas aluminium shrinks 0·2031 in., or 1·69 per cent., other metals shrink less in casting. Aluminium is less affected by dry or damp air, at any temperature, than any of the ordinary metals. The thin film of oxide which develops on its surface, cold or hot, is very resistant; so much so that if a mould is filled too full and part of the metal runs over, the oxide skin may behave as a syphon tube and partly empty the mould.

Mr. Morrison proceeds to refer favourably to Dr. Goldschmidt's process, and expects it to be useful to the aluminium manufacturer. He describes the use of aluminium in freeing iron and steel from occluded gases, saying that it possesses 20 times the deoxidising power of silicon. He quotes some electrical data obtained by Mr. Wilson (*ut infra*), gives a table of the equivalent price of aluminium and copper (*a*) for equal section; (*b*) for equal conductivity; and also another, which we may reproduce, exemplifying the comparative properties of the two metals from the electrician's standpoint.

	Copper.	Aluminium.
Specific gravity	8·93	2·65
Conductivity	100	61
Section for equal conductivity	1	1·64
Diameter for equal conductivity ...	1	1·28
Weight for equal conductivity	1	0·485
Weight for equal section...	1	0·297
Tensile strength for equal section ...	1	0·46
Tensile strength for equal conductivity	1	0·75
Equivalent price for equal section* ...	1	3·37
Equivalent price for equal conductivity*	1	2·03

* These figures have been interpolated by us from another table not reproduced in this abstract.

Thus for equal conductivity aluminium has only three-fourths of the tensile strength of copper, and this may be inconvenient in small wires. Aluminium alloys, however, can be used which involve only an increase of 2 per cent. in the weight and a loss of one or two points in conductivity, while possessing an equal strength with copper per unit of conductivity. With its larger surface the heating effect of c^2R losses ought to be smaller in the case of aluminium than in that of copper. As regards joints, the "McIntyre"—a flattened aluminium sleeve into which the wire ends are inserted and

Table I.

Number of wire.	Specific resistance in 10^{-6} legal ohms at 15° C.	Conductivity in terms of Matthiessen's standard at 15° C.	Temperature coefficient 0° C. 100° C.	Linear coefficient of expansion per 1° C. between 18° and 100° C.	Specific gravity.	Limit. Load in lbs.	Limit. Tons per sq. in.	Break. Load in lbs.	Break. Tons per sq. in.	E. Lbs. per sq. in.	E. Tons per sq. in.	Percentage elongation on 250 mm., including break.	Percentage reduction of area at break.
(1) 1						260	8·71	353	12·64				
2						240	8·60	350	12·53	8,512,000	3,800	1·86	73·6
3						250	8·65	353	12·64				
Averages for (1)	2·762	61·5	·00405	·0000234	2·715	250	8·65		12·60	8,512,000	3,800	1·86	73·6
(2) 1						260	8·71	341	12·21			1·34	
2						250	8·65	342	12·24	8,512,000	3,800	2·32	76·7
3						240	8·60	342	12·24				
Averages for (2)	2·762	61·5	·00405	·0000231	2·715	250	8·65	342	12·24	8,512,000	3,800	2·32	76·7
(3) 1						95	3·4	180	6·44			24·3	89·5
2						95	3·4	180	6·44	1,683,240	751	20·9	85·6
3						95	3·4	180	6·44			22·3	89·5
Averages for (3)	2·762	61·5	·00393	·0000230	2·715	95	3·4	180	6·44	1,683,240	751	22·5	88·2

TABLE II.

No. of wire.	Limit.		Breaking.		E.		Per cent. elongation on 350 mm.		Per cent. reduction of area at break.	Ratio limit ÷ breaking load per cent.
	Load in lbs.	Tons per sq. in.	Load in lbs.	Tons per sq. in.	Tons per sq. in.	Lbs. per sq. in.	Including break.	Not including break.		
1	290	10·32	346	12·39	2,500	5,600,000	1·69		62·4	83·8
2	250	8·95	375	13·42	4,160	9,320,000	1·94	1·40	76·3	66·7
3	275	9·85	375	13·42	3,980	8,916,000	3·15		78·5	73·3
4	220	7·88	316	11·31	3,670	8,220,000	3·44		76·6	69·0
5	255	9·13	320	11·46	4,180	9,362,000	3·20	2·44	76·6	79·7
6	300	10·74	380	13·60	3,020	6,764,000	3·43		81·7	78·9
7	250	8·95	365	13·07	3,790	8,490,000	2·94	1·72	57·2	68·5
8	290	10·38	415	14·86	3,020	6,764,000	4·05	2·54	46·4	69·9
9	275	9·85	375	13·42	3,920	8,780,000	2·05	1·48	68·3	73·3
10	280	10·02	360	12·89	3,740	8,376,000	2·43		70·1	77·8
11	300	10·74	425	15·22	3,690	8,266,000	3·84	3·13	52·4	70·6
12	265	9·49	390	13·96	3,640	8,154,000	2·90	2·16	55·7	67·9
13	400	14·32	480	17·19	3,690	8,266,000	3·71		59·8	83·3
14	400	14·32	500	17·90	3,920	8,780,000	4·19	3·43	66·8	80·0
15	425	15·22	535	19·15	3,860	8,646,000	3·08	1·88	60·7	79·4
16	240	8·59	328	11·74	4,050	9,072,000	3·08	2·54	83·0	73·2
17	225	8·06	390	13·96	3,740	8,376,000	2·32	1·51	60·6	57·7
18	275	9·85	425	15·22	3,790	8,490,000	2·09	0·77	49·0	64·7
19	250	8·95	445	15·93	4,490	10,060,000	2·96		25·4	50·2
20	250	8·95	475	17·01	3,800	8,520,000	4·40	3·33	42·9	52·6
21	300	10·74	520	18·62	3,690	8,266,000	2·62		38·4	57·7
22	450	16·11	565	20·23	4,910	11,000,000	0·57 testing at ordinary rates. 1·83 testing very slowly and carefully.		19·3	79·7
23	300	10·74	435	15·57	3,860	8,646,000	2·25	2·03	49·1	69·0
24	250	8·95	385	13·78	3,690	8,266,000	3·83		60·8	64·9

TABLE III.

Number of specimen.	Analysis.							Specific resistance in 10^{-6} legal ohms at 15° C.	Conductivity per cent. in terms of Matthiessen's Standard taken to be 1.696×10^{-6} legal ohms at 15° C. for copper.	Average temperature coefficient per 1° C. between 0° C. and 50° C.	Average temperature coefficient per 1° C. between 0° C. and 100° C.	Specific resistance after annealing for ½ hour at 435° C. and cooling in air.	Percentage extension with 10,250 lbs. per square inch of cross-section.	Limit of elasticity in lbs. per square inch cross-section.	Breaking load in lbs. per square inch cross-section.	Average linear coefficient of expansion per 1° C. between 15° C. and 100° C.	Specific gravity before annealing at 435° C.	Data for elastic catenary.			
	Si.	Fe.	Cu.	Ni.	Mn	Zn.	Al.											l in 10^6 ft.	c when hung at the standard temperature in feet.	c corresponding to elastic limit in feet.	Fall in temperature required to stress to elastic limit in degrees C.
16	·31	·37	·11	—	—	—	99·21	2·92	58	·00354	·00318	2·83	·177	19,500	26,600	·0000236	2·719	7·7127	1666·4	16,240	89·5
4	·38	·25	·16	—	—	—	99·21	2·88	59·9	·00341	·00324	—	·200	17,900	25,700	·0000234	2·748	6·7885	1597·0	14,917	93·9
13	·38	·25	1·58	—	—	—	97·79	3·34	50·7	·00295	·00283	3·30	·194	32,500	39,000	·0000239	2·748	6·9508	1609·6	27,080	163·0
14	·40	·31	1·86	—	—	—	97·43	3·25	52·1	·00302	·00303	3·18	·183	32,500	40,600	·0000240	2·748	7·3857	1642·5	27,080	152·7
15	·40	·40	2·61	—	—	—	96·59	3·34	50·7	·00311	·00296	3·26	·186	34,500	43,500	·0000241	2·764	7·2309	1631·0	28,750	165·0
1	·38	·22	·17	—	—	·62	98·61	2·86	59·2	·00369	·00357	—	·286	23,600	28,100	·0000245	2·720	4·7574	1418·5	19,667	169·0
2	·43	·28	·30	—	—	1·20	97·79	2·94	57·6	·00346	·00320	—	·171	20,300	30,500	·0000241	2·728	7·8945	1679·4	16,916	88·5
5	·43	·39	·09	—	—	2·04	97·05	3·07	55·2	·00319	·00325	—	·171	20,700	26,000	·0000230	2·749	7·8734	1677·8	17,250	95·3
7	·37	·25	·05	·75	—	—	98·58	3·05	55·6	·00328	·00320	—	·189	20,300	29,700	·0000246	2·723	7·7047	1629·0	16,917	95·5
8	·35	·29	·09	1·19	—	—	98·08	3·24	52·3	·00337	·00320	—	·237	23,600	33,700	·0000236	2·731	5·7253	1508·8	19,667	145·5
20	·37	1·10	·06	2·25	—	—	96·22	3·18	53·2	·00345	·00329	3·14	·189	20,300	38,600	·0000234	2·756	7·1462	1624·6	16,917	101·2
24	·35	1·16	·09	—	—	—	98·40	2·97	57·1	·00365	·00357	2·955	·194	20,300	31,300	·0000248	2·731	6·994	1613·0	16,917	97·6
3	·37	·28	·19	—	—	·59	98·17	3·06	55·3	·00327	·00306	—	·180	22,300	30,500	·0000227	2·732	7·544	1654·2	18,583	108·5
6	·39	·31	·63	—	—	1·20	97·47	3·12	54·3	·00324	·00316	—	·237	24,400	30,900	·0000244	2·742	5·7023	1506·8	20,333	146·1
17	·35	·53	·10	·83	—	·90	97·27	3·03	56	·00324	·00320	3·005	·191	18,300	31,700	·0000236	2·751	7·0382	1616·4	15,250	91·9
12	·31	·59	·19	1·09	—	·73	97·09	3·33	50·9	·00330	·00318	3·18	·197	21,500	31,700	·0000236	2·738	6·8817	1604·3	17,900	110·2
18	·43	·40	·21	1·13	—	1·94	95·89	3·24	52·4	·00342	·00319	3·245	·189	22,300	34,500	·0000245	2·763	7·1004	1621·1	18,583	106·8
19	·35	·29	·11	2·01	—	1·77	95·47	3·26	52	·00263	·00238	3·205	·160	20,300	36,200	·0000225	2·770	8·3952	1714·2	16,917	89·6
11	·39	·56	·24	2·31	—	·38	96·12	3·48	48·7	·00308	·00300	—	·194	24,400	34,500	·0000235	2·741	6·9686	1611·0	20,333	124·1
22	·37	·43	1·08	1·29	—	—	96·83	3·41	49·7	·00173	·00178	3·28	·146	36,600	45,900	·0000252	2·747	9·2532	1770·7	30,500	131
21	·39	2·57	·10	1·39	—	—	95·55	3·24	52·3	·00352	·00320	3·195	·194	24,400	42,200	·0000222	2·770	6·8956	1605·4	20,333	182·8
10	·32	·54	·02	—	·05	—	99·07	3·09	54·8	·00322	·00311	—	·191	22,700	29,200	·0000222	2·722	7·1132	1622·1	18,917	119·7
9	·31	·35	·03	—	·35	—	98·96	3·30	51·3	·00311	·00291	—	·183	22,300	30,500	·0000231	2·738	7·4235	1645·3	18,583	108·4
23	·44	·56	·09	—	1·78	—	97·13	3·49	48·6	·00273	·00245	3·35	·186	24,400	35,300	·0000230	2·750	7·2677	1633·7	20,333	121·6
Pure	·14	·31	Commercial aluminium					2·762	61·5	—	·00393	—	·190	19,376	28,200	·0000234	2·715	7·2473	1632	16,497	97·5
	Hard-drawn copper..							—	98	—	·00388	—	·102	27,850	64,000	·0000170	8·914	4·1814	1853	7,222	102

then twisted up—a riveted joint with pure aluminium rivets for strip, and a cigar-shaped cast joint, have all proved satisfactory. In making the latter, aluminium is melted in the ladle of a portable forge, and poured into a split-mould containing the ends of the wires. At Foyers there are six miles of No. 12 S.W.G. telephone wire of pure aluminium supported on poles 50 yards apart. The joints have given no trouble, but the wire has broken occasionally, being much exposed to high winds. Another line about one mile long of 0·38 in. wire, carried on poles 40 yards apart, is nearly five years old, and has given absolutely no trouble.

Mr. Morrison next quotes a list of the American transmission schemes and installations in which aluminium conductors have been used or proposed—a list we need not reprint. And, finally, he comes to the question of employing aluminium for covered conductors. For low tension work aluminium cannot compete with copper unless the cost of dielectrics falls considerably; but in high tension transmission the position is somewhat different. As Mr. O'Gorman has shown, for a given voltage there is a certain section of copper which gives the cheapest cable. For instance, at 20,000 volts, with paper insulation and lead sheathing, 0·4 sq. in. is the best copper section. But supposing that in a given situation 0·25 in. of copper would carry the current needed; by substituting for it 0·4 sq. in. of aluminium

a cable of equal electrical capacity would be obtained, which would cost from £150 to £170 per mile less than the copper one, and being lighter would reduce the expense of laying. The tensile strength of the conductor in insulated cables is not important, so that pure aluminium could be always adopted to get the advantage of its maximum conductivity.

Mr. Wilson's paper is a very valuable one, as it gives a large number of physical and mechanical tests of "commercially pure" aluminium of known composition and of 24 different "light" alloys of which the analyses are recorded. Before coming more closely to the subject, we must plead guilty to a suspicion that the percentage of actual aluminium in many of the samples was determined by difference. We hope we are wrong. If we are correct, the defect is a serious one; in either event Mr. Wilson should have stated explicitly how the chemical results were obtained. With a few exceptions, including a digression upon the elastic catenary, Mr. Wilson's paper is not capable of verbal abstraction; practically its whole value lies in his tables, which we reproduce herewith. Table I. gives the tests of commercially pure aluminium, *i.e.*, a metal containing "about" 99·6 per cent. of aluminium, 0·31 per cent. of iron and 0·14 per cent. of silicon. These tests were carried out on three different specimens of wire, 0·126 in. in diameter, each being examined in three states:—(1) as received; (2) after being annealed in an oil bath at 100° C., and cooled slowly in the oil; (3) after being annealed at 430° C. for two hours and cooled in the air. It will be seen that the tensile properties are much altered by annealing at the higher temperature. Tables II. and III. give the results obtained on the examination of various aluminium alloys, all in the form of wires 0·126 in. in diameter, the composition of which is mentioned in Table III., where the materials are arranged in groups according to the special ingredients. The tensile tests were made on the wires after heating to 100° C. Among the data for the elastic catenary, l is such a length that $w\,l$ is the modulus of elasticity assumed to be independent of temperature, and c is such a length that $w\,c$ is the tension at the lowest point of the wire; w in each case being the weight of a unit length of the unstretched wire at the standard temperature.

In general the effects produced by an addition of various foreign metals to aluminium can best be seen by an inspection of the tables, but the following remarks may be made: Not much is gained in tensile strength by adding from 1·5 to 2·5 per cent. of copper. Up to 2 per cent. of zinc scarcely influences the tensile strength; but the conductivity of the alloy is higher than that of the corresponding copper one. Nickel has a marked effect on the breaking load, but the limit of elasticity remains low. The ternary nickel-copper alloy No. 22 shows the highest tensile strength of the whole series. [This is presumably "romanium."] The fall in temperature in the last column of Table III. shows that the greater lightness of aluminium and greater percentage extension, counteract the effect of greater linear coefficient of expansion.

Discussing the use of aluminium for overhead conductors, Mr. Wilson seems to agree that several of the breakages which have been recorded in the past were due to lack of uniformity in the composition of the wire. The material is more homogeneous now. Since the cross-sectional area of a wire varies as the square of the radius, while the area exposed to wind and snow varies as the radius itself, it follows that for a given material the larger the diameter the better. Comparing aluminium with copper, the total tensile strength of an aluminium wire of the same total conductivity as the copper may be greater according to the alloy chosen, and this may compensate for the increase in the surface exposed to the wind. For single small wires, where great tensile strength is required, the nickel-copper alloys might be further experimented with, but their use would involve a sacrifice of conductivity. For large single or stranded conductors, pure commercial aluminium should be found sufficiently strong, and it possesses the maximum of conductivity. As regards corrosion, a sample of wire used to transmit current for four years at Foyers "cannot be said to have seriously suffered." In bad districts, where chemical works are situated, large single wires should be preferable to stranded conductors, as the surface exposed to the air would be less.

INSTITUTION OF ELECTRICAL ENGINEERS.

A PERMEAMETER FOR TESTING THE MAGNETIC QUALITIES OF MATERIALS IN BULK.

By Charles V. Drysdale, D.Sc., Associate.

(*Abstract of Paper read November 28th*, 1901.)

(*Concluded from page* 1060.)

In fig. 6 the complete set is shown, which differs from the last only in the addition of the milliammeter A and the resistance dial B, increasing the length of the case to 16½ in. The galvanometer G

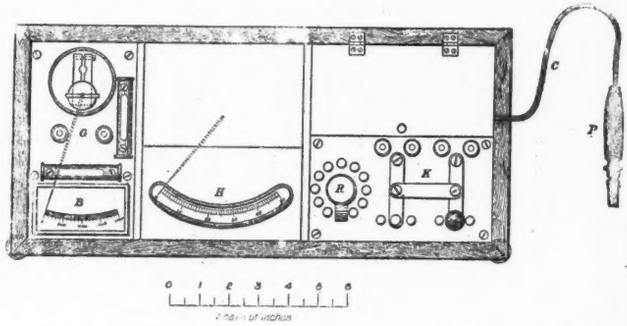

Fig. 6.—Complete Set for Permeability and Magnetisation Tests.

is then arranged to read the values of B and also the values of μ when H = 100. The total and residual magnetisation curves are obtained as before, while the cycles are determined by observing the throws corresponding to successive variations of the resistance and summing them in the well-known manner. Fig. 7 shows total

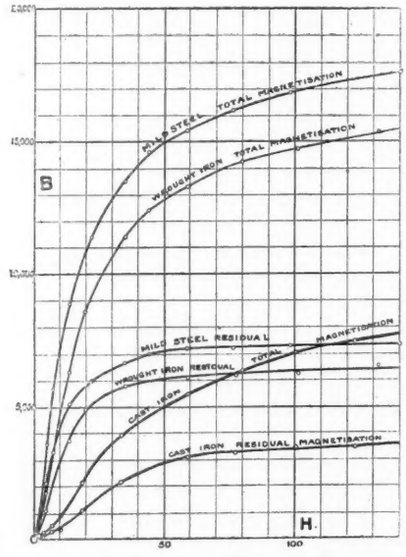

Fig. 7.—Curves of Total and Residual Magnetisation.

and residual magnetisation curves for three specimens of mild steel wrought-iron and cast-iron, while figs. 8 and 9 represent the corresponding B-H cycles obtained in this way.

Details of Construction and Calibration.

The drills must all be made accurately to gauge so as to be interchangeable. In order to make them more easy to centre truly in drilling they are now made with a certain amount of relief in the bottom cutting edges.

To make the magnetic joints as perfect as possible the plug is very carefully turned to have the same angle as the drill, and the central hole the same diameter as that of the pin. In order, however, to ensure perfect contact, the plug is split longitudinally as will be seen on looking back at fig. 1, so that on pushing it into place it grips tightly on the pin. Great care is taken to have the bottom edge of the aperture in the plug quite sharp, so as to give certainty in the length of the pin used.

The magnetising and search coils are wound on an insulated brass bobbin split longitudinally to prevent eddy currents. This bobbin is screwed to the end of the plug in such a manner as to still allow

of the yielding due to the slit, and the ends of the coils are brought up through the plug as shown.

In order to arrange for a perfectly definite length of specimen a standard piece of steel is kept which has been drilled in the ordinary manner and afterwards cut through near the edge of the

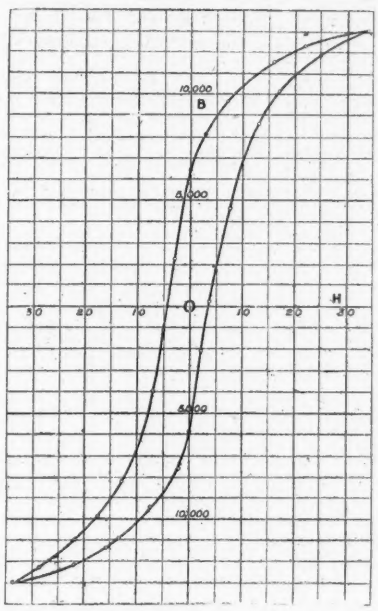

Fig. 8.—B-H Cycle for Mild Steel.

cavity so as to expose the interior. The plugs are then turned or ground down until, when they are pushed home in this specimen, the length of the pin exposed is exactly $\frac{1}{2}$ in. Since the value of H is $\frac{4\pi}{10}$ the ampere-turns per centimetre length, the number of turns required for the current in milliamperes to equal H in gausses is

$$\frac{10^6}{4\pi \times 39{\cdot}37 \times 2} = 1{,}010 \text{ turns.}$$

In calibrating the ballistic galvanometer it must not be forgotten that, being a moving coil instrument on a small external resistance, the damping is considerable, as indeed is necessary in a commercial

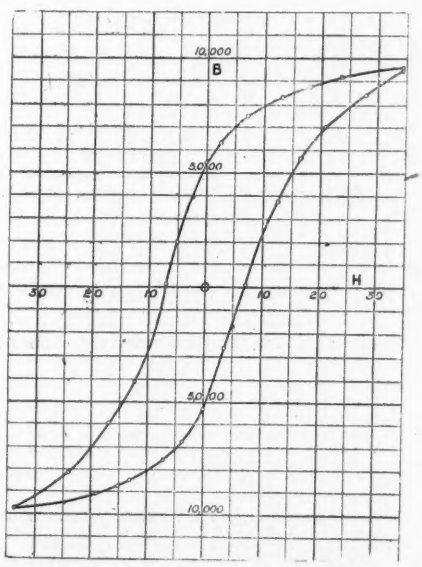

Fig. 9.—B-H Cycle for Wrought-Iron.

instrument. Standardisation of the galvanometer by condenser is therefore unsatisfactory, and the best procedure is to obtain the throw corresponding to a known current and a known coefficient of mutual induction, or with a search coil and magnet previously measured on some other galvanometer.* If the search coil is of low resistance and is interposed in the galvanometer circuit the damping will be unaffected. Terminals are provided on the instrument which will allow of this test being made should it be necessary.

* The Hibbert standard inductor may be conveniently employed.

The small size of the pin makes the gap between it and the search coil of some influence on the results, as the coil not only cuts the lines passing through the pin, but those in the annular space between it and the search coil. The effect is not large, but it can easily be allowed for by the simple expedient of winding a few turns of wire in the magnetising and search-coil circuits round a bobbin. A reading is first taken by reversing the current without the iron core. Then if D is this deflection, d_1 and d_2 the diameters of the pin and search coil, the deflection due to the space may be approximately taken as $\frac{d^2 - d_1^2}{d_2^2}$ D. The number of turns in the compensating coil is adjusted to give this deflection, in the opposite direction, and thus eliminates the effect entirely. The compensating coil is shown in figs. 2 marked C C.

The highest value of H employed is 100, which corresponds to 100 milliamperes of current from the cells. As this is only on for the time of making and throwing over there should not be much trouble with deterioration of the cells.

A clamp is provided for fixing the coil of the galvanometer when not in use, and levelling screws are mounted in the base of the case.

Accuracy of the Method.

It now remains to see what reliance may be placed in the results obtained.

The first point to determine was whether the diameter and effective length of the pin tested could be relied on with sufficient accuracy. The effective length of the specimen was determined by drilling out some holes with the specimen drill and afterwards cutting a longitudinal section of them near the edge. On inserting the plug the interior of the hole could then be seen, and the distance between the bottom of the plug and the end of the pin could be accurately measured with a reading microscope. These measurements were repeated several times, removing and reinserting the plug between each set of readings, and it was found that the greatest variation from the mean did not exceed ·0008 of an inch, which in a length of half an inch means a variation of less than ·2 per cent. In the same way several pins were broken out of the holes after being drilled; and the greatest variation of the diameter was found to be less than half a mil, or less than 1 per cent. of the area of section.

It will be seen from the above that the results may therefore be relied on to within 1 per cent. as far as the dimensions are concerned.

The readings appear to reproduce themselves with the most perfect accuracy. In a deflection of 230 divisions obtained with a certain value of the current in a cast-iron specimen a variation of one division in the deflection was very rare, although the plug was taken out and reinserted between the readings, and no particular care was used in replacing it. The perfection of the magnetic joint obtained by the conical fit appears to be all that can be desired, and is certainly better than can be obtained by any ordinary faced joints.

Some fear was at first felt that the great disproportion between the sizes of the specimen and return path might lead to error, as too low a flux density in the return path would imply a low permeability. Careful tests have been made on this point by turning down the outside of a drilled specimen and taking magnetisation curves after each turning down. The result, however, has shown that the reluctance of the return path may be taken as negligible whenever the external diameter of the specimen exceeds the diameter of the hole by more than an eighth of an inch.

It may be asked whether the drilling of so small a specimen does not injure the pin. No trace of any twisting has been found although frequently looked for, and the consistency with which the results agree even in different drillings, seems to show that the method is reliable.

The wearing of the drill is a point upon which little experience has been obtained as yet. The experimental drill, which was first made up about six months ago and has had a fair amount of use, has never been sharpened and shows no signs of wear.

In conclusion, I can only hope the method will commend itself to engineers, and that it will be found satisfactory after extended use.

The sole point upon which experience is required is in the drilling of the specimens. We have never yet found any trouble in drilling specimens of metal such as can be put on a lathe, but for larger castings, &c., some form of portable drilling machine would be necessary. Should any difficulty be found in getting the drill properly centred, it would probably be well to drill a shallow hole first, with an ordinary twist drill or rose cutter, and any trouble as to wearing of the drills could be avoided by keeping a standard drill for a finishing cut.

Finally, I must express my most cordial thanks to my assistants at the Northampton Institute for the help they have given me in the construction of the apparatus and its testing.

Institution of Electrical Engineers (India).—We gather from a Madras paper that the first annual meeting of the above section was held on November 22nd in Calcutta, in the rooms of the Asiatic Society of Bengal. Prof. Bruhl was in the chair. The secretary said that they had a balance in hand of Rs. 47, and outstanding subscriptions of Rs. 85. They had now 46 members in Calcutta out of 90 in all India. There had not been a plentiful supply of papers sent in, but they had been able to arrange for four papers to be read, one on the last Friday in each month, commencing from December.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, Manchester and Birmingham, price, post free, 9d. (in stamps).

1900.

2,050. "Improvements in controlling electrically-propelled vehicles." E. H. Tyler. Dated February 1st, 1900. To control the speed of electrically-propelled vehicles, arrangements are made so that the series motors can be connected up to return energy to the supply conductors, or to send current through a resistance. In either case a braking effect is produced.

2,104. "Improvements in electric railways and tramways on the surface contact system." W. F. Stamp. Dated February 2nd, 1900. Electric railways and tramways on a road-contact system, with switches operated by electro-magnets on the vehicle. Spring-mounted rollers are connected through a bar and fuse to the main, and the circuit to the vehicle is completed by the wedge-shaped ends on the bridge-piece when that is lifted by the plunger by electro-magnets on the vehicle. The plunger works in an oil well, which is surrounded by resistances for heating purposes. The magnets are excited by a shunt from the motor circuit, and the bar which connects the poles may serve to pick up current from the bridge-piece.

2,119. "Improvements in or relating to junction boxes for electric conductors." L. M. Waterhouse and the Simplex Steel Conduit Company. Dated February 2nd, 1900. Junction boxes for conductors carried in tubes are provided with main branch nipples. The box is provided with insulators for the connecting pieces, and a separating bridge is formed in one with the insulators. The connecting pieces are formed in two parts, the ends being drilled to form sweated connections from the mains. Transverse holes with pinching screws are provided for the branches.

2,120. "Improvements relating to electric switches." L. M. Waterhouse and the Simplex Steel Conduit Company. Dated February 2nd, 1900. Relates to a coupling arrangement by which two ordinary tumbler switches may be coupled to form a double-pole switch. Two bars have countersunk holes, which receive the spherical heads of the switch handles, and so form ball-and-socket joints. The bars are separated by a distance piece at the centre, and are connected by screws by which the joint can be adjusted.

2,150. "Improvements in telephone transmitters." G. Dallaire. Dated February 2nd, 1900. Microphones are constructed with a carbon block attached to the diaphragm and connected to the line terminal by a wire. The back electrode consists of a block with platinum contacts mounted on a spiral spring, and provided with a spring-adjusting lever and a screw. The base is closed by the cap, and the diaphragm is held in position by a washer and mouthpiece.

2,176. "Improvements in regulating mechanism for arc lamps." A. Eckstein and A. E. Angold. Dated February 3rd, 1900. A brake strap in a regulating mechanism is attached at one end to a spring drum, which takes up slack and keeps the strap in contact with the brake pulley except when the regulating lever has turned so far that the brake pulley is to be allowed to slip and the carbons to be fed together by the greater weight of the upper carbon holder. At such time a pawl pivoted on the regulating lever engages a toothed sector carried by the spring drum, and stops the action of the spring until the regulating lever has been returned by the increase of current due to the feed. The regulating lever is a frame fulcrumed centrally and operated electro-magnetically. It carries the cores of series and shunt solenoids, one end of the brake strap being attached to the shunt end of the lever; the brake strap is provided with rubber pads, and is passed under one of three grooves in the pulley, the carbon holders being hung by cords from the other two grooves, on opposite sides. The spring drum may be raised relatively to the pawl, which then engages sooner and slackens the brake strap by causing some rotation of the toothed sector and drum, or the drum may be lowered to produce the opposite effect.

2,197. "Improved magnetic holding table for metal-working machines specially adapted for holding flat articles down on it." W. H. Lock and M. Barr. Dated February 3rd, 1900. A magnetic table for metal-working machines consists of an iron or steel box with a perforated brass cover and containing magnet cores secured to the bottom. The cores are flush with the outside of the cover, only alternate cores being wound so as to produce a uniform field with a number of opposite magnetic poles. The article to be held is mounted on an iron or steel plate which is held down by the magnets and is prevented from sliding by stops having stems fitting in holes in the cover, and notched heads which may be turned by a screw-driver to bring eccentric portions against the plate.

2,212. "Improvements in electric arc lamps." W. Peritz. Dated February 3rd, 1900. Electrodes are enclosed in a sealed or stoppered glass globe, which contains an inert gas or is exhausted as completely as possible to prevent consumption of the electrodes. The electrodes may be movable, or provided with a movable core, to strike the arc. The arc in such a lamp may be enclosed in the mantle of refractory material, preferably a mixture of rare earths; if necessary, this is insulated from one or both of the electrodes by glass placed at some distance from the arc.

2,219. "Improvements relating to the measurement of electric power and energy." R. Arno. Dated February 23rd, 1900. Power or work is measured on a systematically-loaded three-phase alternating current system by an ordinary electro-dynamometer or commutator motor-meter, the current coils of which are inserted in one main, while the pressure coil or armature is connected between that main and another of the three, this pressure circuit being made of such resistance and inductance that the current in it lags 30° in phase behind the pressure applied at its ends. The loads on the system may be inductive.

2,222. "Improvements in electricity meters." A. Wright and the Reason Manufacturing Company. Dated February 3rd, 1900. Quantity meters.—A mercury voltmeter consists of a glass vessel, closed by a stopper at the top, or entirely sealed, containing a mercury anode in a pocket at a higher level than a mercury cathode and having platinum connecting wires sealed into it. The vessel is filled with a solution of mercurous nitrate, or other suitable electrolyte. When the instrument is in use, the mercury cathode increases in volume, and overflows a lip or ridge into a long vertical tube which at starting contains solution only; the mercury passes to the lip or ridge through a small hole in a side tube, or under a glass partition near the lip, to prevent a large quantity from passing over at a time. The position of the anode causes the dense solution produced on its surface to flow down to the cathode. To avoid interference with this circulation by the anode being reduced below the level of the lip at the edge of its pocket, the vessel may be formed with an auxiliary bulb from which mercury is supplied automatically to maintain the anode surface at its proper height. The height of the mercury in the vertical tube is measured by an adjacent scale, indicating the quantity of electricity which has passed. The instrument is reset by turning it over to the left, and then replacing it. It is used shunted.

2,231. "Telephone ear instrument holder." A. H. Stamp. Dated February 5th, 1900. Holders for telephones, whether used on the table or wall, have an adjustable vertical rod provided with a rotating cap carrying an arm at the end of which is an adjustable clip for the receiver.

2,260. "Improvements in electric arc lamps." H. Bremer. Dated February 5th, 1900. A lamp has its carbons fixed, or periodically fed by clockwork, which is released by a solenoid; or the carbons may be carried in inclined holders, one of which is movable towards the other by an electro-magnet in a shunt circuit, when this circuit is closed by expansion of a metal tube situated above the arc and heated by it; the tube and contact in the shunt circuit may be replaced by a magnesia or like rod, which becomes conductive when heated by the arc. A long arc is produced, and is controlled by an adjacent solenoid or electro-magnet, connected in series with the arc, and tending to deflect the arc and lengthen it if the main current increases. The deflecting magnet may be provided with a shunt winding acting in opposition to the main current winding. The arc may be struck by a shunt electro-magnet actuating an armature carrying a piece of carbon or metal, to first connect and then leave the carbons. The carbons are preferably arranged side by side, either parallel or inclined, with the deflecting magnet between them, and the arc may be formed within a glass cylinder, open below but having a metal cover to retain hot gases. A loop of tube may lead from the cover to a lateral receptacle and back to the glass cylinder, so that gas may circulate through it and deposit impurities in the lateral receptacle. Each carbon may pass through a separate cylinder. The carbons may contain metalloids or metal salts.

2,271. "Improvements in or relating to electric devices for explosion engines." A. J. Boult. Dated February 5th, 1900. Two-cylinder engines are provided with two induction coils the primary circuits of which are made and broken by a cam pressing two spring blades successively against the terminals and suddenly releasing them. The cam is carried on a sleeve to keep oil away from the contacts, and these are enclosed in a casing. The disc may be adjusted about the shafts for timing the ignition. The mass of the engine forms part of the conductors of both the primary and secondary circuits.

2,282. "Improvements in dynamo-electric machines." G. Dalen and A. Hultqvist. Dated February 5th, 1900. Dynamos of the "unipolar" type are constructed with two or more rotating discs, which are in contact with one another at or near their peripheries, and move in magnetic fields so arranged that currents flow from the centre of one disc to the centre of the other. In the apparatus two metallic discs mounted on parallel shafts rotate in magnetic fields produced by windings. The current flows from the centre of the one disc to the centre of the other disc, and is taken off by sliding contacts on the shafts. The discs may be furnished with yielding rims and set in different planes. Two or more sets of discs may be provided, in which case they are so connected that their electromotive forces are added together.

2,340. "Improvements in telephones." E. Ducretet. Dated February 6th, 1900. A magnetic telephone is constructed with an exciting coil mounted on a frame capable of adjustment as regards the diaphragm. The line coil is mounted inside the magnet, and has a core adjustable by means of the screw. The coil may be fixed, and the line coil may be sub-divided; the current in the coil may be regulated by a rheostat, &c. A magnetic exciter may be arranged over the diaphragm.

2,856. "Improvements in apparatus for regulating the electric lights on theatre stages." Siemens Bros. & Co. (Communicated.) Dated February 6th, 1900. An apparatus for controlling the lighting of a theatre stage by groups of lamps consists of rheostats in circuit with the groups, and separately connected by weighted cords by sector levers which are mounted on a single shaft so that each lever rheostat and group of lamps may be separately regulated, or the whole may be varied together, to either increase or diminish the light, commencing with the parts in any positions, by turning the shaft with all the levers by a hand-wheel and toothed gearing.

2,357. "Improved electro-magnetic bell signalling apparatus." Siemens Bros. and Co. (Communicated.) Dated February 6th, 1900. Relates to electric bell signalling apparatus for use on ships, in mines, &c., and more particularly to means for protecting the bell mechanism from moisture.

2,370. "Improvements in means for maintaining a constant speed of a driven shaft, electric generator, or other revoluble part." G. C. Dymond. Dated February 6th, 1900. Relates to means for maintaining constant the speed of a shaft or other revoluble part driven by a shaft which rotates at a varying speed. The invention is shown in connection with a dynamo, which may be the spark generator of a gas engine. The armature spindle carries at one end a friction roller adapted to be rotated by the fly-wheel of the gas engine, and at the other a governor; it is mounted in a pivoted frame which is, by means of a spring tilted towards the fly-wheel to keep the roller in gear. When the speed rises too high, the governor, acting through the sleeve and lever, the end of which engages the head of a fixed stud, tilts the frame in the opposite direction, and keeps the roller out of gear until the speed has fallen.

2,384. "Improvements in 'in-and-out' indicators." W. M. Mordey. Dated February 6th, 1900. Choking coils are arranged in circuits having capacity to minimise the injurious effects of such capacity. The coil or coils are in parallel to the capacity, and may be near the generator or in the middle of the circuit. The coil also serves as a path for the discharge of current when a switch or cut-out is suddenly opened. One arrangement comprises an alternating current generator, a self-induction coil, and switches or cut-outs. The choking coils may be simply helices, or may have iron cores, the end pieces of which are capable of adjustment to vary an air-gap. In one construction the core is built up of iron laminæ, the portion being adjustable by means of bolts and nuts. In polyphase systems of distribution, compensating induction coils are arranged in connection with each conductor.

2,409. "Improvements in electrolytic and like electrodes, and in electrical resistances." H. A. Kent. Dated February 7th, 1900. Electric conductors, to take the place of platinum as electrodes for electrolysis, or primary or secondary batteries, or as resistances or as heat generators, are formed of ground or sanded glass, or unglazed porcelain plates, sheets, tubes, rods, or vessels of any shape. A thin coating of platinum or gold is first formed thereon by either (1) painting or flowing platinum solution or liquid gold thereon, and heating to a red heat to reduce to the metallic state, or (2) pouring a tin chloride solution thereon, washing, and afterwards applying a gold or platinum solution in caustic soda together with a few drops of glycerine, and keeping the article warm until the film has been deposited. After cooling, a solution of platinum chloride is applied, and the article heated to render the coating metallic. These two processes may be reversed, or one may be omitted. The article is next used as a negative electrode in an electrolytic bath consisting of a hot solution of sodium or ammonium phosphate and platinum chloride, whereby an electrolytic deposit of platinum is obtained.

2,473. "Improvements relating to electric arc lamps." E. C. de Marsay. Dated February 7th, 1900. Arc lamps.—An arc is produced at the free ends of a fixed carbon rod and a surrounding hard carbon helix which may be cut from a tube by grinding. The carbons and arc may be enclosed in a globe, in which case the carbons will preferably be made like incandescent lamp filaments.

2,543. "Improvements in and connected with primary batteries." Maquay. Dated February 8th, 1900. Relates to improvements in the battery described in Specification No. 19,536, A.D. 1898, in which the internal resistance can be varied.

2,621. "A new or improved safety and indicating device for electric circuits." A. and E. Ruhstrat. Dated February 9th, 1900. Relates to an appliance for indicating when there is a short circuit in a lighting circuit. In the arrangement a lamp is in shunt with the main fuse. A short circuit is indicated when the fuse blows by the lighting of the lamp, the other lamps being dim or extinguished. The lamp may be protected by a fuse.

2,662. "Improvements in brush-holders for dynamo-electric machinery." Lancashire Dynamo and Motor Company, A. P. Wood, and R. S. McLeod. Dated February 10th, 1900. The body of the holder is formed of a brass stamping, having bearings for the carrying spindle at one end, and a spring jaw for receiving the carbon brush at the other. The carrying spindle is mounted in an adjustable bracket, which also supports a notched plate. By means of an arched plate spring, one end of which is secured to the body of the holder while the other is pivoted in one of the notches in the plate, the brush is either pressed against the commutator, or is retained in the off position. Instead of the notched plate, a screw with a recessed head for receiving the pivot may be employed.

2,670. "Improvements in the production of electric incandescent lamps." G. T. Hutchinson and H. J. Packard. Dated February 10th, 1900. A bulb is provided with two pairs of leading-in wires, one pair carrying an iridium, or carbon filament, and the other a piece of magnesium wire, or ribbon; the bulb is closed without exhaustion, and a current then passed through the magnesium to ignite it, and so consume the oxygen in the bulb, after which the filament may be used. The bulb may have a screw joint to permit renewal of the filament and magnesium.

2,742. "Improvements in apparatus for firing submarine mines by means of Hertzian radiations." F. Maylander. Dated February 12th, 1900. Relates to apparatus for firing submarine mines by means of Hertzian radiations.

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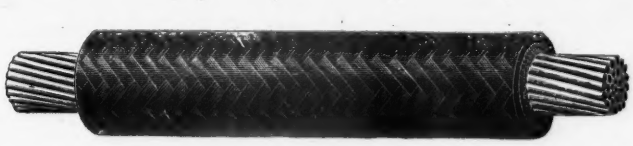

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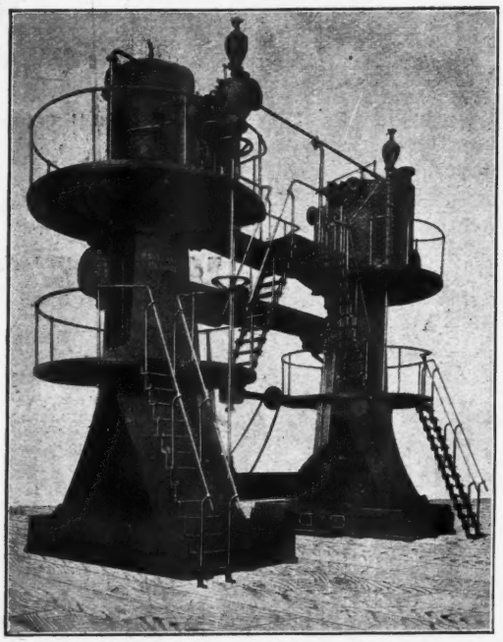

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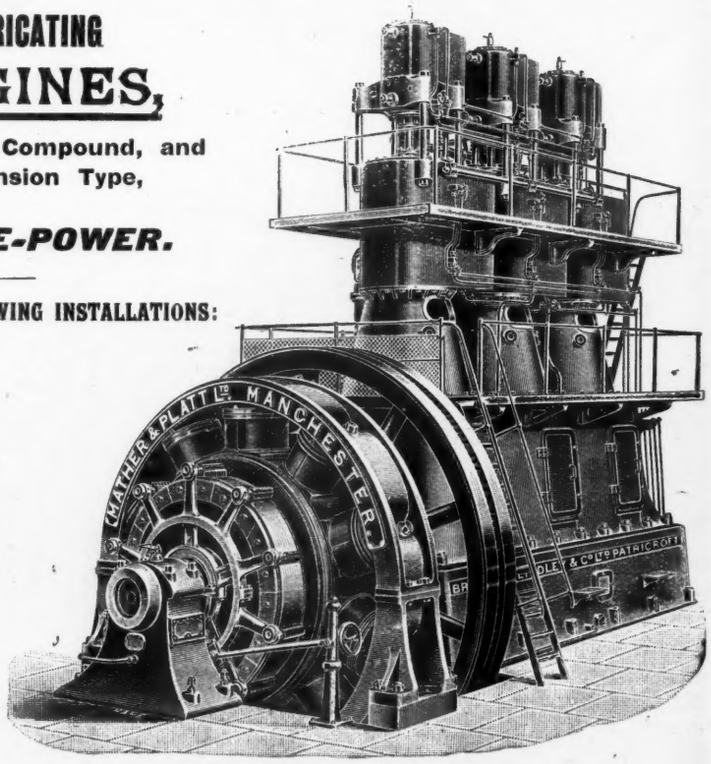

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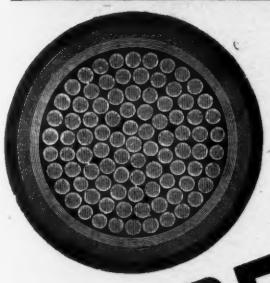

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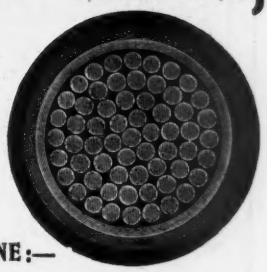

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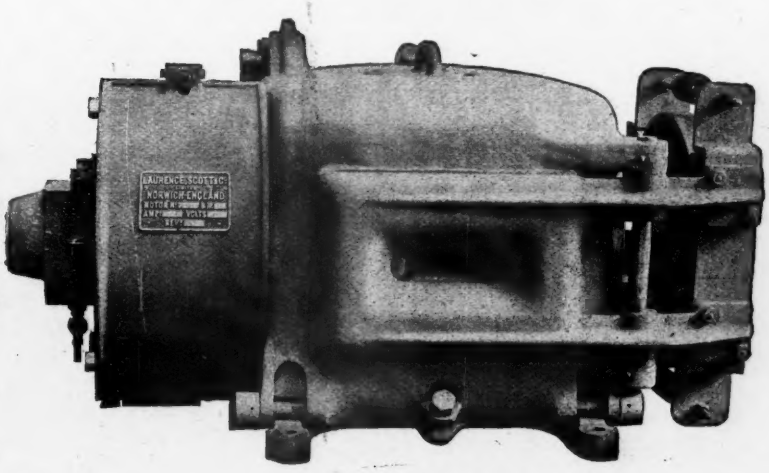

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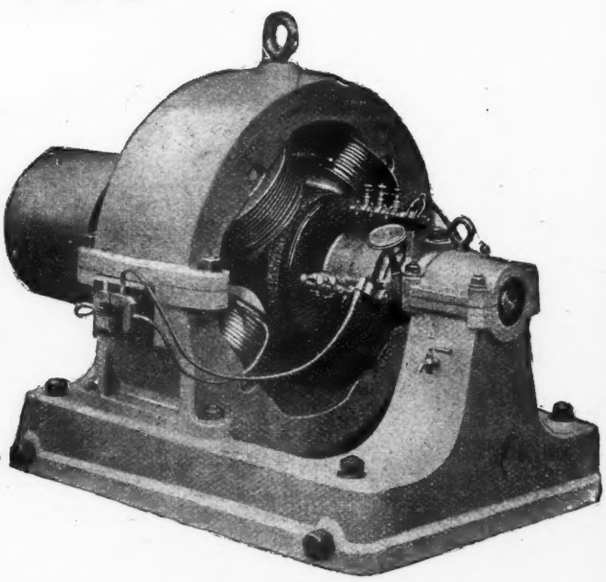

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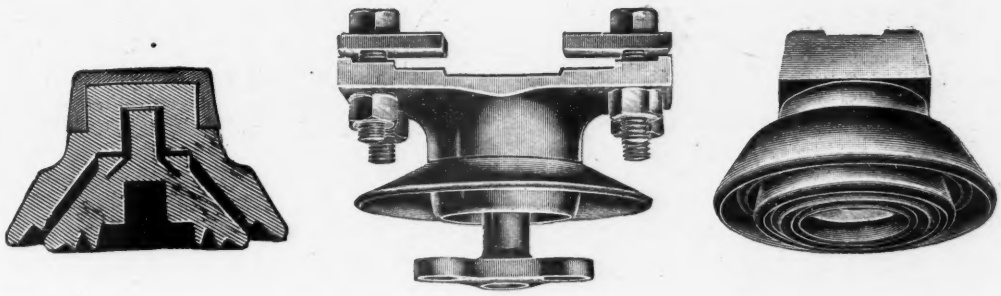

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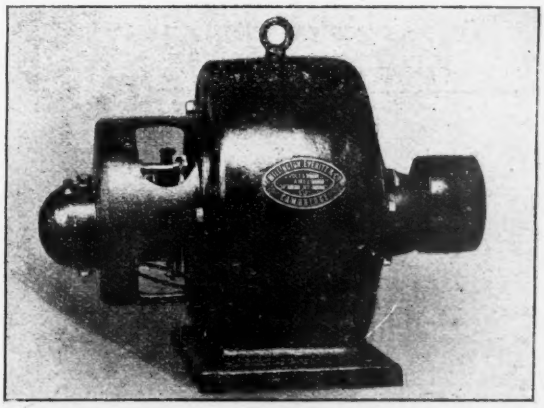

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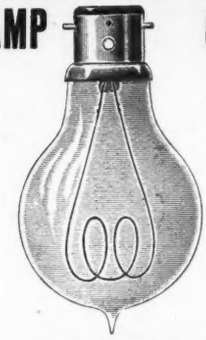

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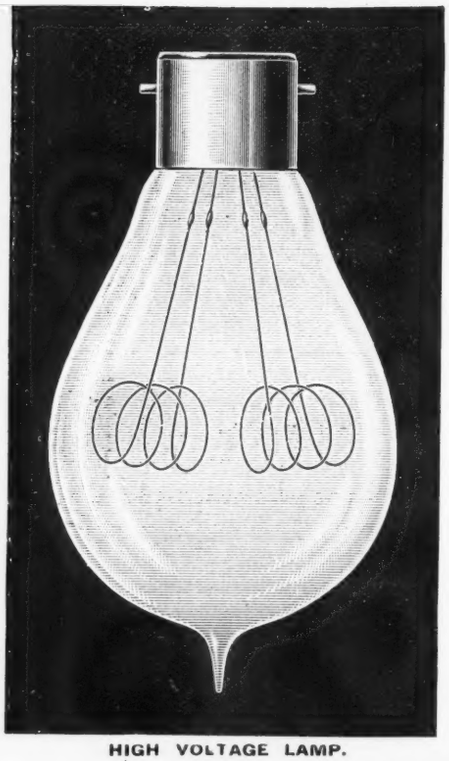

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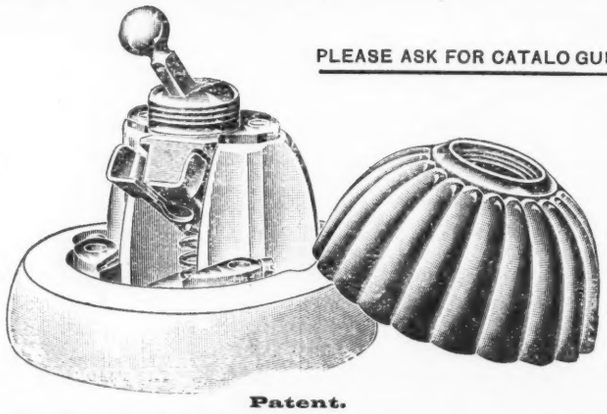

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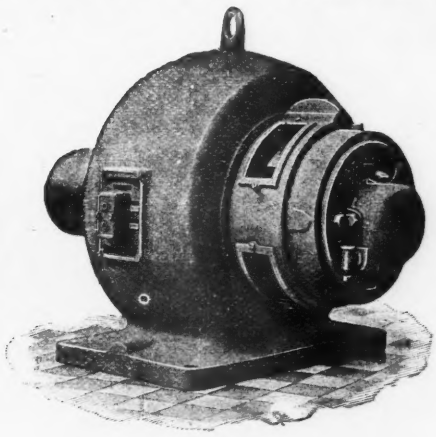

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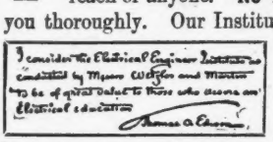
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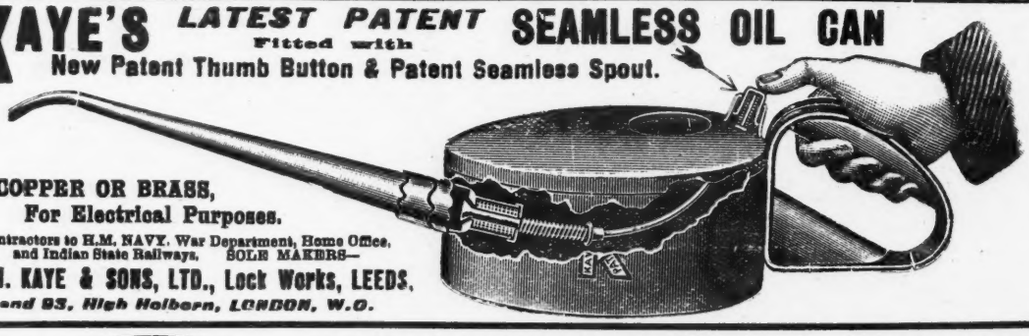

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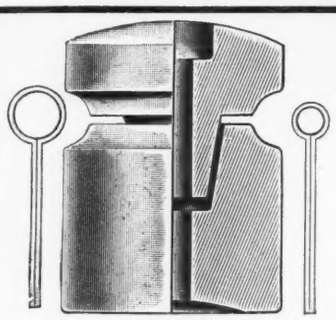

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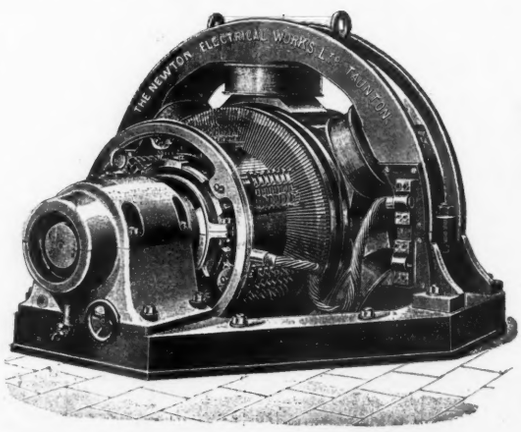

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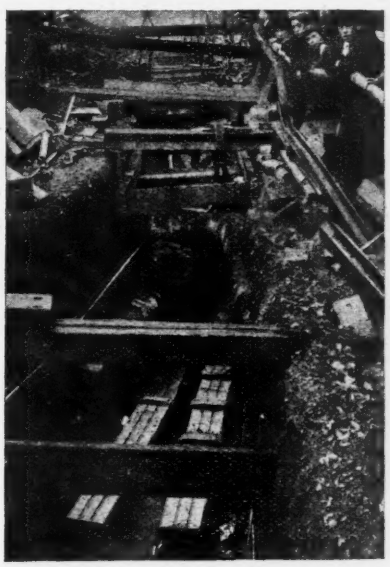

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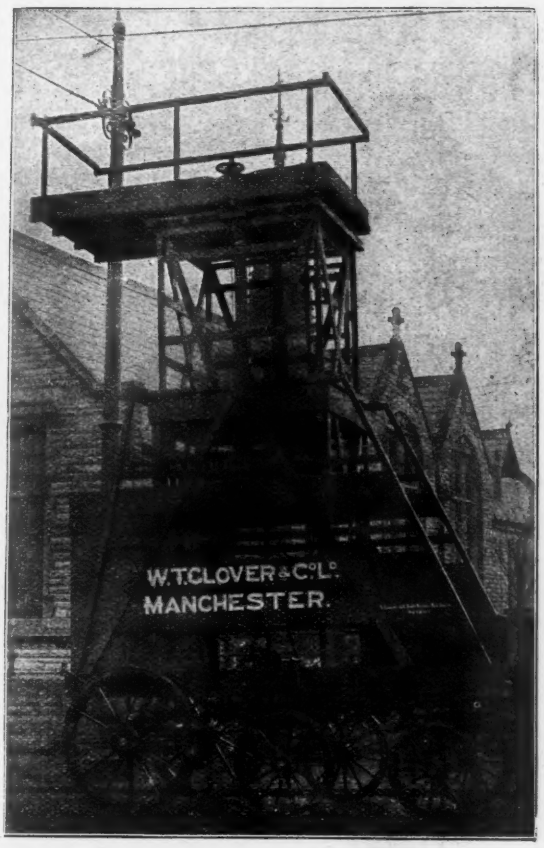

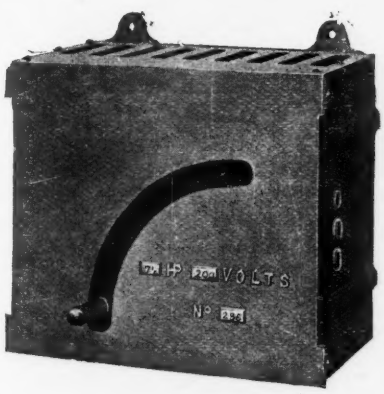

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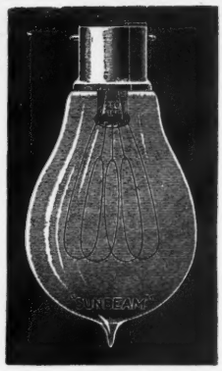

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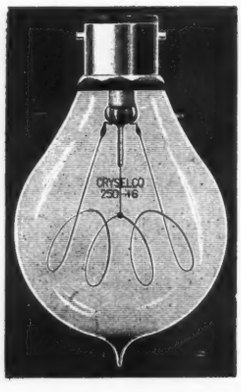

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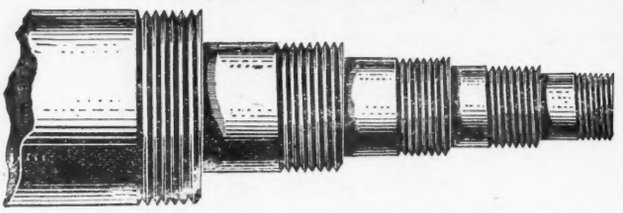

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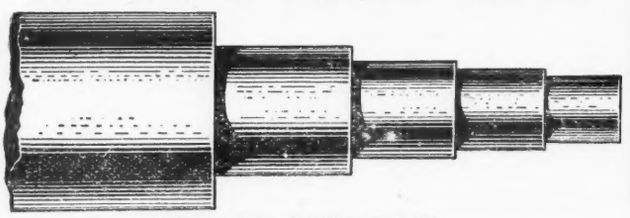

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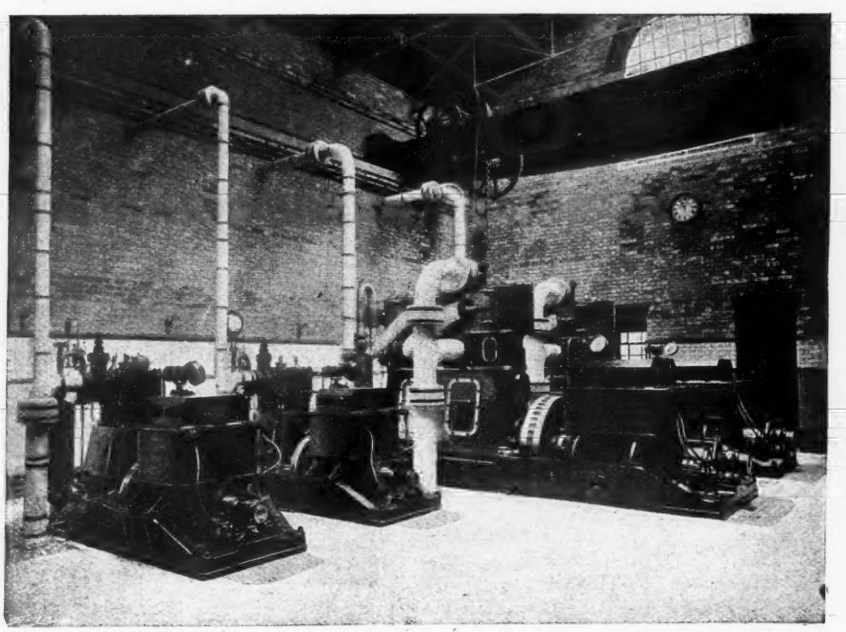

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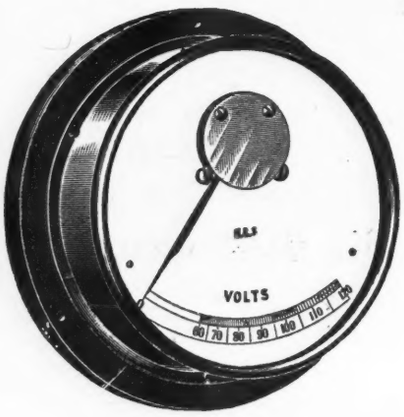

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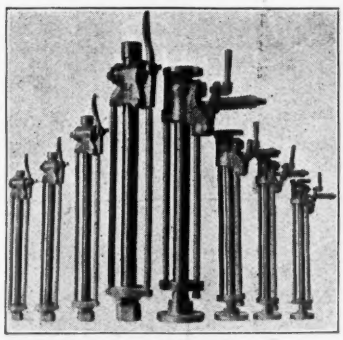

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" B.—Bromford Lane.
" C.—Handsworth Boundary to Carter's Green.
" D.—Carter's Green to Wednesbury Boundary.
" E.—Carter's Green to Great Bridge.

SECTION No. 3.—Supply and Erection of Trolley Poles.

SECTION No. 4.—Supply of Bonds, and supply of and erection Overhead Line, Insulators and Section Boxes.

SECTION No. 5.—Supply, Laying and Jointing of Lead-covered Cables.

Plans and Detail Drawings may be inspected, and Specifications, Conditions, and Forms of Tender obtained on application to the undersigned and on payment of Five Guineas (cheque only), which will be returned on receipt of a *bona fide* tender and documents intact.

Plans and Detail Drawings, with Specifications and Conditions may also be inspected at the offices of the Consulting Engineer, Mr. ROBT. C. QUIN, M.I.E.E., M.I.Mech.E., Electricity Works, Blackpool, or 32, Victoria Street, London, S.W.

Sealed Tenders, endorsed "Tramways—Section —, Division —," must be forwarded to the Town Clerk, West Bromwich, not later than noon on the 17th day of JANUARY, 1902.

The Council do not bind themselves to accept the lowest or any tender, and reserve the right to divide the Sections as they think fit.

ALBERT D. GREATOREX,
Assoc.M.Inst.C.E.,
Borough Engineer.

Town Hall, West Bromwich,
December 17th, 1901.

5052

Official Notices.—*Continued.*

CITY OF MANCHESTER.

ELECTRICITY DEPARTMENT.

THE ELECTRICITY COMMITTEE of the Manchester Corporation are prepared to receive Tenders for the supply, delivery and erection at their Stuart Street Generating Station of the following:—

SPECIFICATION G.—SWITCHBOARDS.

A.—Main High-tension Three-phase Switchboards at Generating Station.
B.—Exciter and Auxiliary Switchboards at Generating Station.
C.—High-tension Three-phase Switchboards at Ten Sub-stations.
D.—Low-tension Switchboards at Ten Sub-stations.

Specifications, Drawings, and Forms of Tender, may be obtained on application to Mr. F. E. HUGHES, Secretary, Electricity Department, Town Hall, Manchester, on payment of the fee of Five Guineas, which amount will be returned on receipt of a *bona fide* tender.

Further information may be obtained on application to Mr. G. F. Metzger, Chief Engineer, Dickinson Street Works, Manchester.

Tenders duly endorsed "Switchboards," and addressed to the Chairman of the Electricity Committee, must be delivered at the Town Hall not later than 12 o'clock noon on TUESDAY the 21st JANUARY, 1902.

The Corporation do not bind themselves to accept the lowest or any tender.

WM. HENRY TALBOT,
Town Clerk.

Town Hall, Manchester,
13th December, 1901.

5036

COUNTY BOROUGH OF BOURNEMOUTH.

BOURNEMOUTH CORPORATION TRAMWAYS.

Contract No. 13.

THE BOURNEMOUTH TOWN COUNCIL invite Tenders for the following:—

FEEDER CABLES, PILOTS, ARC LIGHTING CABLES, CONDUITS, &c.

Forms of Tender and Specification may be obtained of the undersigned, provided that the sum of £3 3s. has been deposited at the Borough Engineer's Office, which deposit shall be forfeited unless a tender complying with the conditions is sent in, and unless the Form of Tender, Specification and Conditions, and other particulars are returned with same intact.

Further particulars may be obtained and drawings seen at the Office of the Consulting Engineers, **Messrs. LACEY, CLIREHUGH and SILLAR, 2, Queen Anne's Gate, Westminster.**

A further deposit of a £20 Bank of England Note is to accompany the Tender.

These deposits will be returned to those whose Tenders are not accepted, but in the case of the accepted tender will be retained until the execution of the contract, and will be forfeited if the person whose tender is accepted does not find the necessary sureties and sign the contract prepared by the Town Clerk within one week from the date of notification of the acceptance of the tender.

Tenders to be sent in, in envelopes provided for the purpose, to the Town Clerk (J. Druitt, Jr., Esq.), on or before noon of MONDAY, JANUARY 6th, 1902.

The Council do not bind themselves to accept the lowest or any Tender.

F. W. LACEY, M.Inst.C.E.,
Borough and Tramway Engineer.

Municipal Offices,
Bournemouth,
December, 1901.

5034

(Continued on next page.)

Official Notices.—*Continued.*

BOROUGH OF MIDDLESBROUGH.

ELECTRICITY WORKS.

THE ELECTRIC LIGHTING COMMITTEE of the Borough of Middlesbrough invite Tenders from manufacturers for the supply and erection of the following plant for the Extension of their Electricity Works:—

SECTION A.—ENGINE HOUSE PLANT.
One 300 KW. High-speed Steam Dynamo and Accessories.

SECTION B.—SWITCHBOARD PANELS.
Panels and Instruments for dealing with the above plant and three new Feeders.

SECTION C.—CONDENSING APPARATUS AND PIPEWORK.
Ejector Condenser for dealing with 8000 lbs. of Steam per hour.
Steam Exhaust and Feed Pipes.

SECTION D.—FEED PUMP AND ECONOMISER.
One Feed Pump.
Extension to existing Economiser.

The whole bound up in one Specification.

Applicants must state for which Section or Sections they wish to tender, in order that the requisite drawings may be forwarded to them.

Tenderers are at liberty to tender for either Section, but not for part of a Section.

Specification, with Terms and Conditions, and Forms of Tenders, may be inspected at the offices of Mr. ROBERT HAMMOND, M.Inst.C.E., the Consulting Engineer to the Council, 64, Victoria Street, Westminster, London, S.W., and may be obtained there on and after the 23rd day of December, on making a deposit of £5 5s., which sum will be refunded to *bond fide* tenderers after the tenders are adjudicated upon. Extra copies of the Specification may be obtained by *bona fide* Tenderers at a charge of five shillings per copy, which sum will not be refunded. Tenders (sealed and marked "Tender for Electricity Works") must be addressed to me at the Town Hall, Middlesbrough, and be delivered on or before 4 p.m. on Tuesday, the 21st day of January, 1902.

Each Tender must contain the names of two Sureties who will be prepared to execute a joint and several Bond for the due performance of the Contract in the sum of 10 per cent. of the Contract amount.

The Council do not bind themselves to accept the lowest or any Tender.

GEORGE BAINBRIDGE,
Town Clerk.

Middlesbrough,
December 16th, 1901. 8643

HIRE-PURCHASE OR ASSISTED WIRING SCHEME.

THE ELECTRICAL COMMITTEE of the Metropolitan Borough of Stepney are desirous of receiving propositions from substantial wiring contractors for the installation of Electric Wires, Lamps and other Fittings, on the premises of private consumers in the Borough on the basis of a fixed annual charge per point wired.

The Committee do not bind themselves to accept the lowest or any tender.

Propositions must state full particulars and conditions under which the firm will carry out the work, and must be sent to this office not later than 12 o'clock THURSDAY, JANUARY 9th, 1902, in sealed envelopes endorsed "Tenders for Wiring, and addressed to the Chairman of the Electrical Committee, 27, Osborn Street, E.

ARTHUR WRIGHT,
Consulting Engineer. 8705

Official Notices.—*Continued.*

COUNTY BOROUGH OF GRIMSBY ELECTRICITY DEPARTMENT.

THE CORPORATION OF GRIMSBY are prepared to receive Tenders for the Extension of the Plant at the Electricity Works. The work is divided into 5 Contracts as follows:—

Specification No. 10.—Steam Dynamo.
,, No. 11.—Extension of Switchboard.
,, No. 12.—Accumulators.
,, No. 13.—Condenser Plant and Pipework.
,, No. 14.—Water-Tube Boiler.

Copies of Specification, with Forms of Tender, Drawings and General Conditions, can be obtained from the Borough Electrical Engineer, Mr. W. A. VIGNOLES, on payment of a deposit of £1 1s. for each Specification, to be returned by the Corporation on receipt of a *bona fide* Tender.

Tenders on the prescribed form in sealed envelopes and endorsed on the outside "Electric Lighting, Tender for Specification No. —," must be delivered at the office of the Town Clerk, St. Mary's Gate, Grimsby, on or before 9 a.m. Monday, January 20th, 1902.

The Corporation do not bind themselves to accept the lowest or any Tender, and no allowance will be made for any expenses ncurred in the preparation of any Tender.

W. GRANGE,
Town Clerk.

Town Clerk's Office,
Grimsby,
December 23rd, 1901. 8707

EVERSHED & VIGNOLES, Ltd.,
MAKERS OF ALL KINDS OF
ELECTRICAL INSTRUMENTS.
See Advertisement December 20th. 8714

BELLISS & MORCOM LTD.
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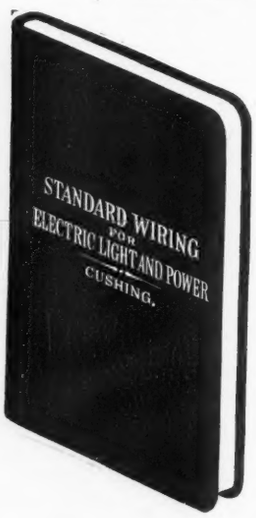

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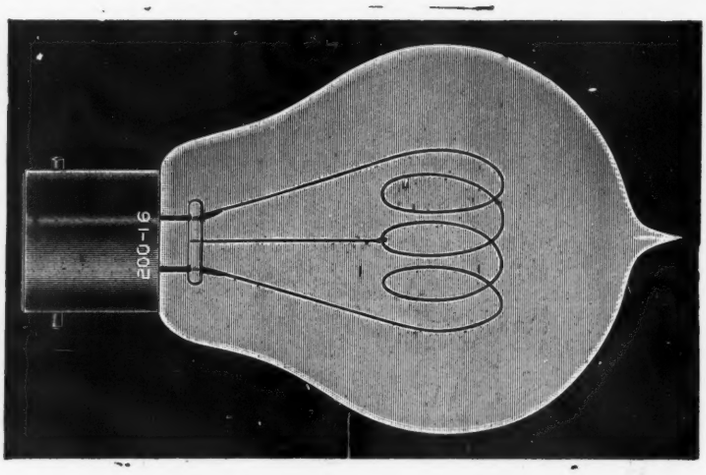

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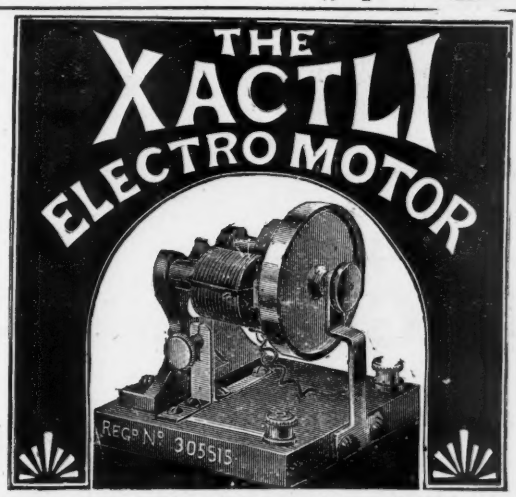

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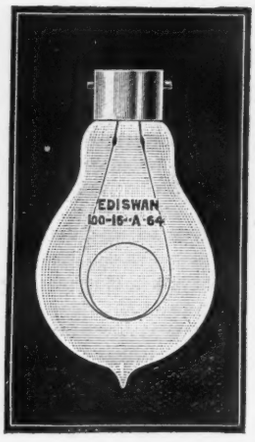

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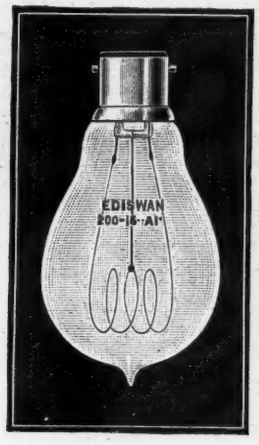

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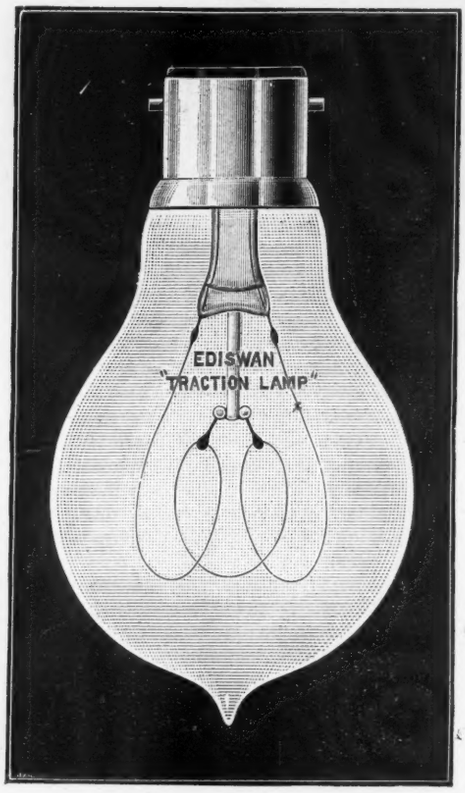

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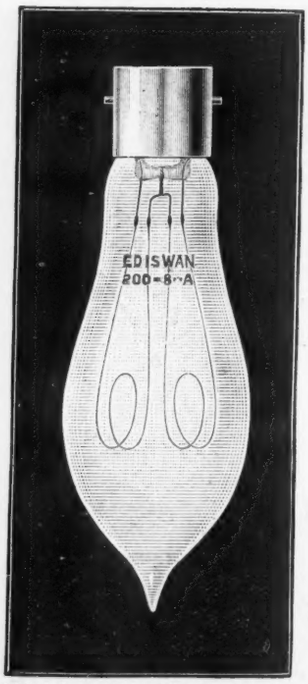

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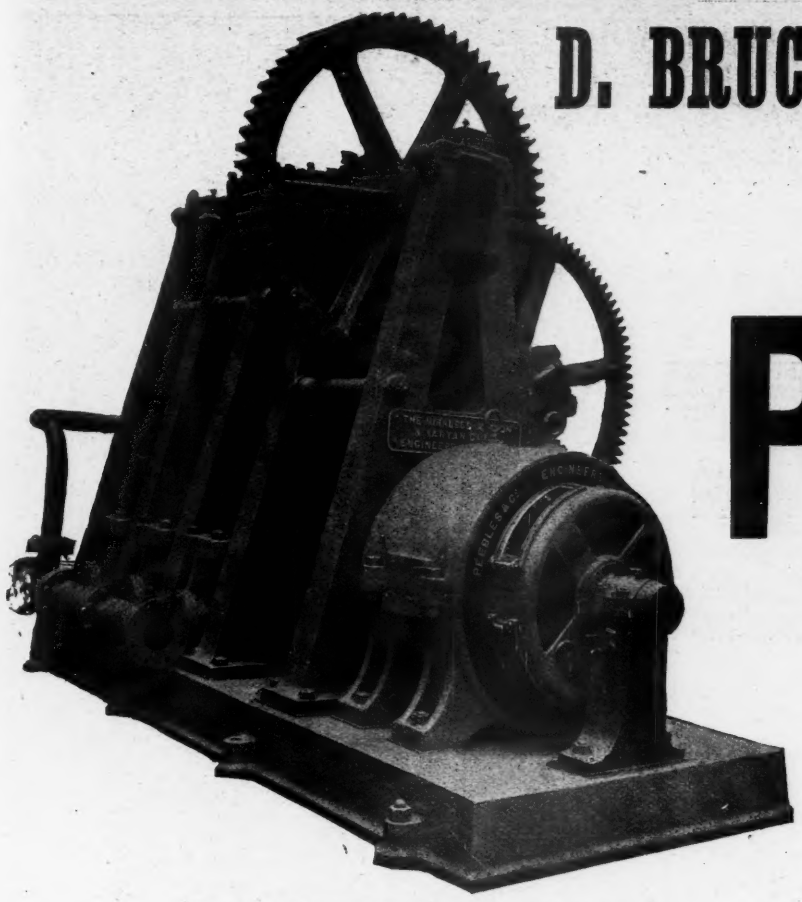

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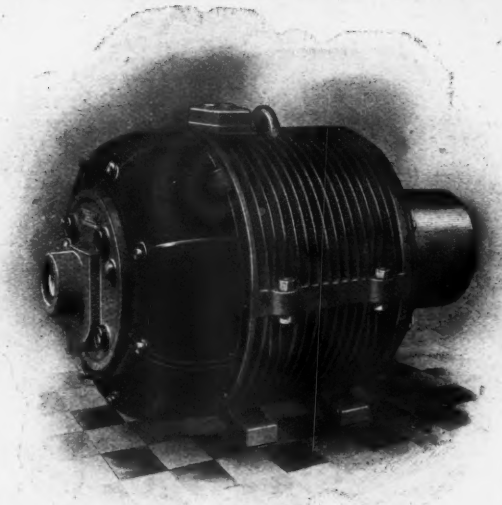

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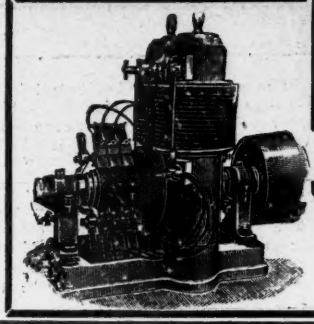

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THE ELECTRICAL REVIEW.

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Relating to Situations Vacant, Situations Wanted, Businesses Wanted, Businesses for Sale, Patents for Sale, Specific Articles of any kind Wanted, or for Sale or Exchange, are inserted at the rate of ONE PENNY Per Word (minimum 1s.).

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The "Electrical Review," is the recognised medium of the Electrical Trades,

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The Practical Electrician's

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1902

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SITUATIONS VACANT.

If letters are not to be delivered to certain firms or individuals (if known), instructions to that effect should be sent to the Manager of the ELECTRICAL REVIEW, who will do his best to carry out such instructions. Letters of applicants cannot in such cases be returned to them, nor can the names of Advertisers using a number or a *nom de plume* in any way be disclosed.

Original Testimonials should never be sent.

METROPOLITAN BOROUGH OF BERMONDSEY ELECTRICITY AND DESTRUCTOR DEPARTMENT.

Appointment of Engine Driver, Cable Jointer and Arc Lamp Trimmer.

APPLICATIONS are invited for the following posts:—

ENGINE DRIVER.—Applicants must have had sole charge of running of high speed engines, one used to Willans engines preferred. Wages 38s. per week of seven 8-hour shifts.

CABLE JOINTER.—Applicants must be used to concentric and three-core paper cable. Wages 9½d. per hour.

ARC LAMP TRIMMER.—Applicants must have held a similar position. Wage 32s. per week.

Applications, stating age, experience, and enclosing testimonials, must be received not later than JANUARY 2nd, 1902, addressed to the undersigned.

W. H. VINCENT, M.I.E.E.,
Borough Electrical Engineer.

Electricity and Destructor Works,
Spa Road, S.E.,
December 21st, 1901. 8701

METROPOLITAN BOROUGH OF HACKNEY.

ELECTRICITY WORKS.

Appointment of Distributing Engineer.

THE ELECTRIC LIGHTING COMMITTEE of the Hackney Borough Council are prepared to receive applications for the post of Distributing Engineer.

Applicants must have undergone a course of technical training as an Electrical Engineer, and have had adequate experience with the continuous current three-wire system and triple concentric cables.

Each of the candidates selected by the committee to appear before the Borough Council must be prepared to undergo an examination as a test of his ability to perform the duties of the post.

The Engineer appointed will have charge, under the directions of the Borough Electrical Engineer, of the distributing system in connection with the Electricity Supply Undertaking, and will be required to devote the whole of his time to the service of the Council.

The commencing salary wil be £250 annum.

Applications, with copies of recent testimonials, sealed and marked "Distributing Engineer," must be addressad to me at the Town Hall, Hackney, and delivered not later than 4 p.m., on Monday January 6th, 1902.

The gentleman appointed will not be entitled to pension.

No application form will be issued.

Canvassing will disqualify any candidate.

GEORGE GROCOTT,
Town Clerk.

Town Hall,
Hackney, N.N. 8704

SWITCHBOARD ATTENDANT required must be used to paralleling of alternators and have experience with continuous three-wire system.

Wages, 30s. per week.

ELECTRICITY WORKS,
Ayr, N.B. 50.9

(Continued on next page.)

SITUATIONS VACANT.—*Continued.*

HORSHAM URBAN DISTRICT COUNCIL.

Electricity Department.

WANTED:—

1. Engine Driver used to high-speed engines and generators, central station man preferred, and capable of doing small repairs; wages 30s. per week 56 hours.

2. Stoker used to Babcock & Wilcox boilers, Green's economiser, steam and motor pumps; wages 25s. per week 56 hours.

3. Switchboard Attendant, used to three-wire continous current system, with batteries; wages 20s. per week 56 hours.

Applications, marked 1, 2 or 3, to be sent to the undersigned, stating age and experience, with copies of three recent testimonials, not later than JANUARY 1st, 1902.

W. J. PROCTOR, A.M.I.E.E.,
Electrical Engineer.

Electricity Works,
Horsham, Sussex. 5709

SOUTH LANCASHIRE TRAMWAYS.
LIVERPOOL AND PRESCOT LIGHT RAILWAY.

Engineer-in-Chief.

THE SOUTH LANCASHIRE ELECTRIC TRACTION AND POWER COMPANY, LIMITED, invite applications for the appointment of a Chief Electrical and Tramway Engineer thoroughly competent to supervise the construction and working of electric tramways.

Salary to commence at £500 per annum.

Applications must contain full particulars, including qualifications, experience, age, &c., with copies only of testimonials, and be sent by post endorsed "Appointment of Engineer-in-Chief," to arrive not later than WEDNESDAY, JANUARY 15th, 1902, addressed to

THE CHAIRMAN AND DIRECTORS OF
The South Lancashire Electric Traction and
Power Company, Limited,
12, St. John's Lane, Liverpool.

By Order,
ALFRED TRACEY,
Secretary.

December 16th, 1901. 5688

Where Advertisements are to be answered to a given number, letter, or *nom de plume* at the ELECTRICAL REVIEW Office, applications for names and addresses of the Advertisers will be entirely disregarded.
Cheap Prepaid Advertisements are inserted under this heading at the rate of One Penny Per word (minimum 1s.). Three Consecutive Insertions for the price of two.
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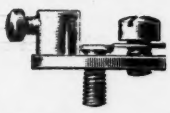

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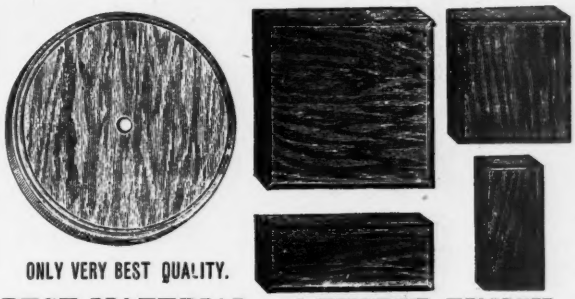

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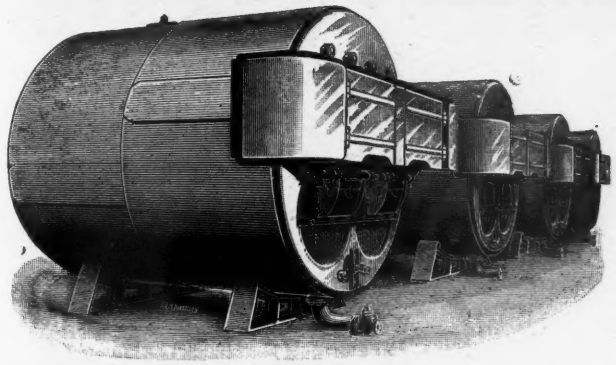

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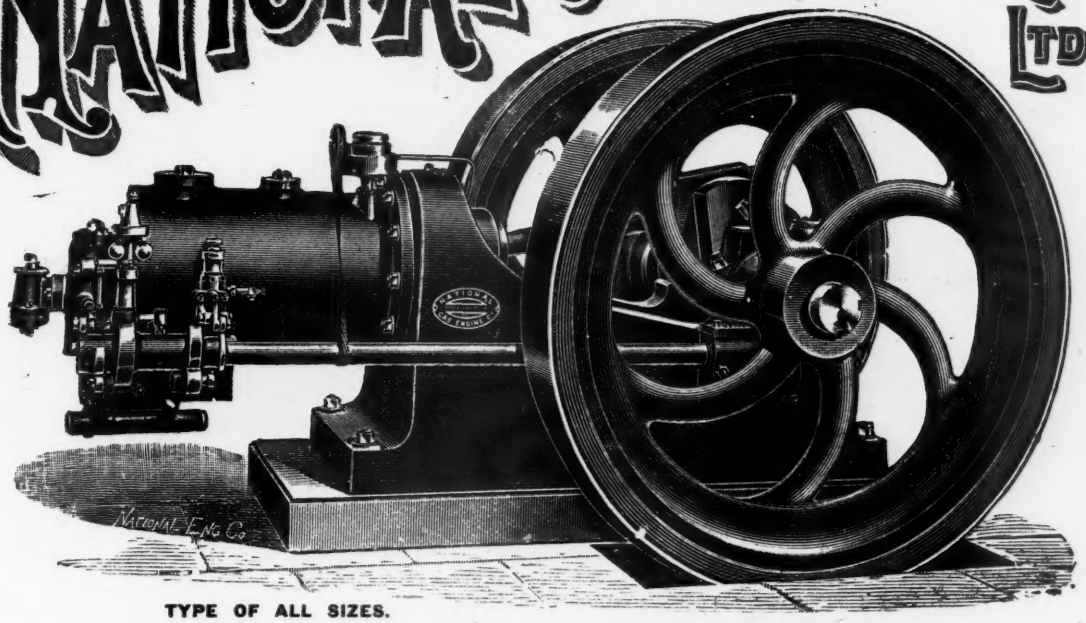

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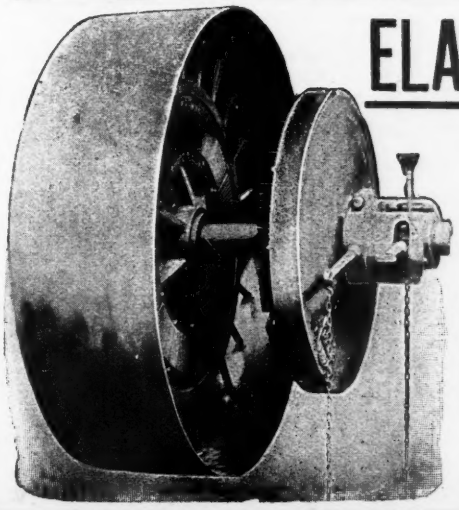

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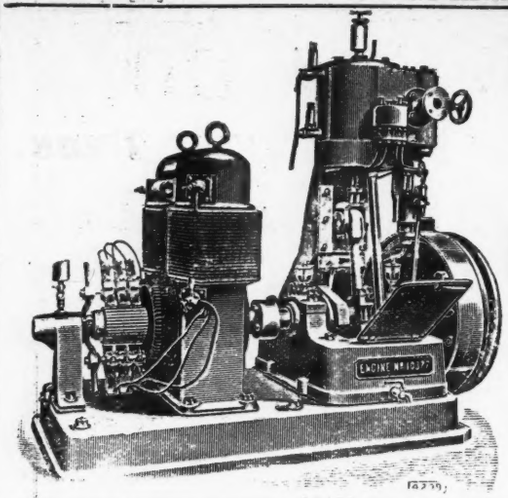

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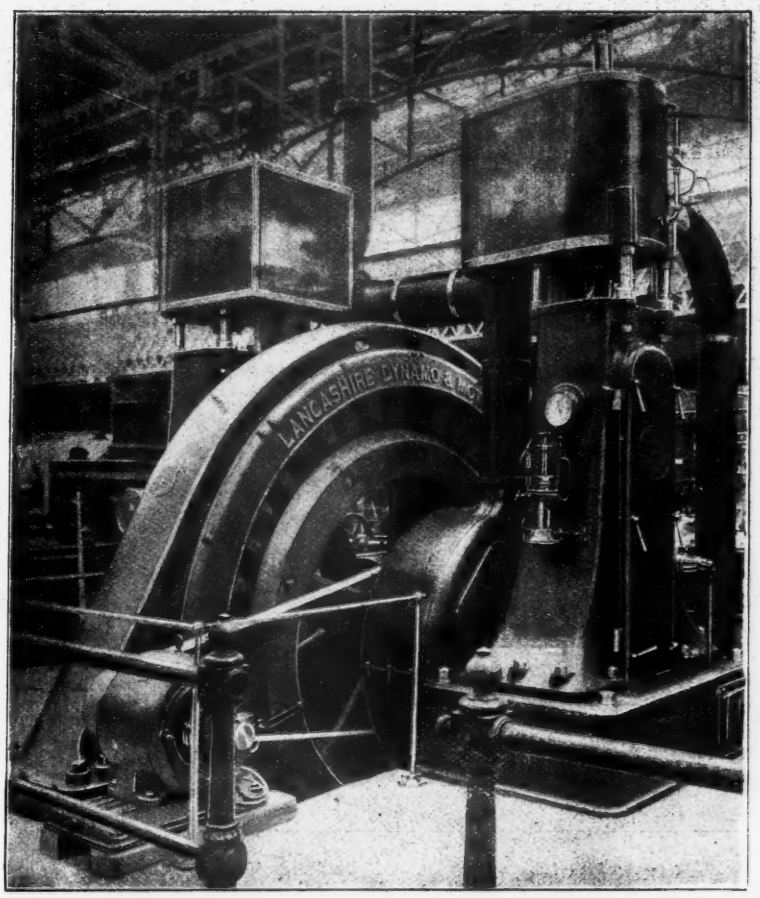

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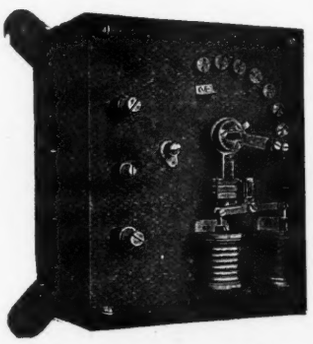
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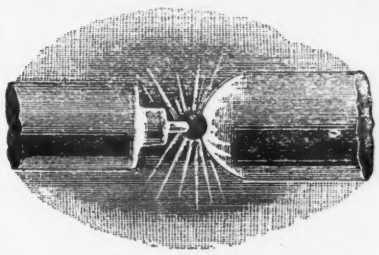

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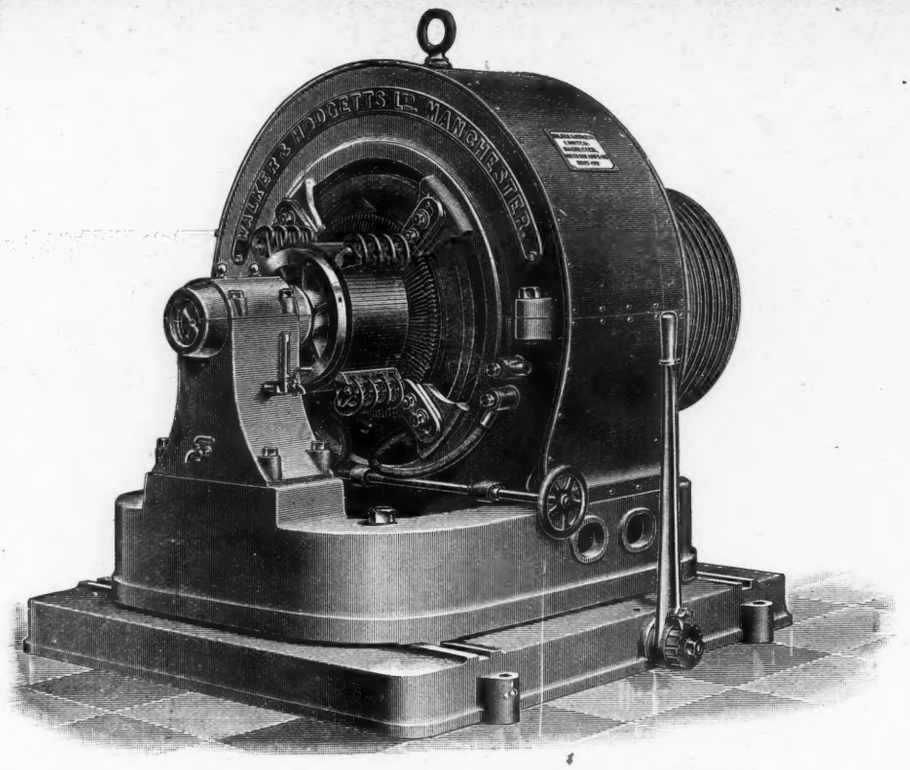

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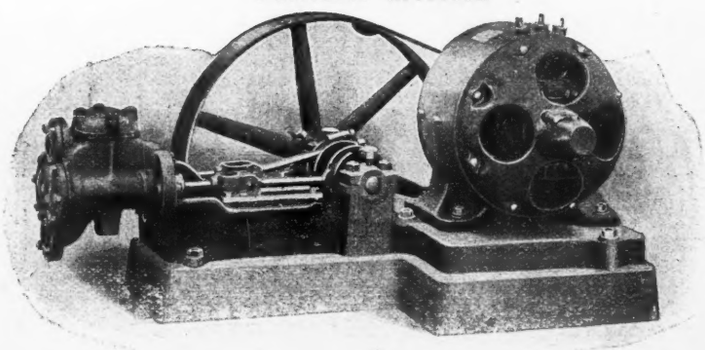

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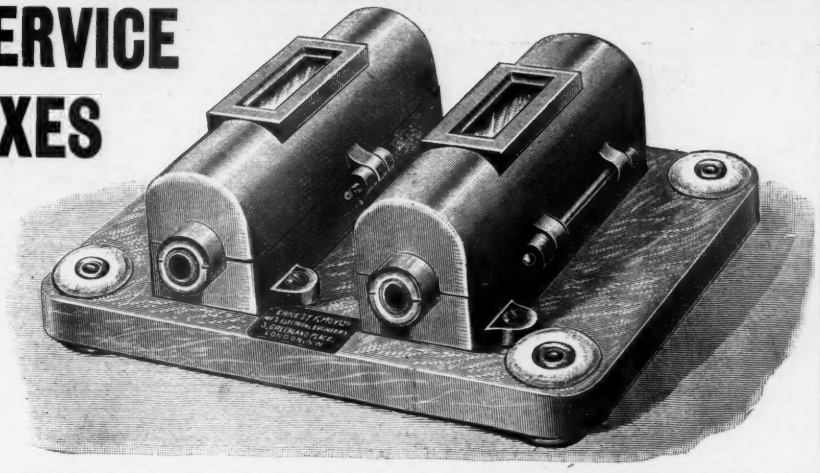

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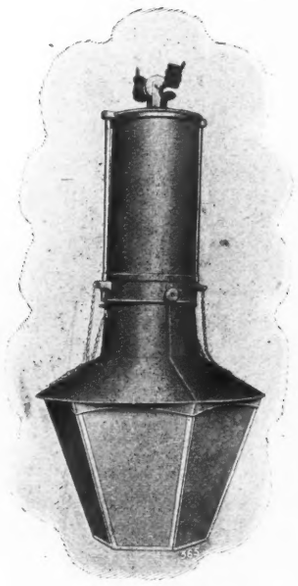

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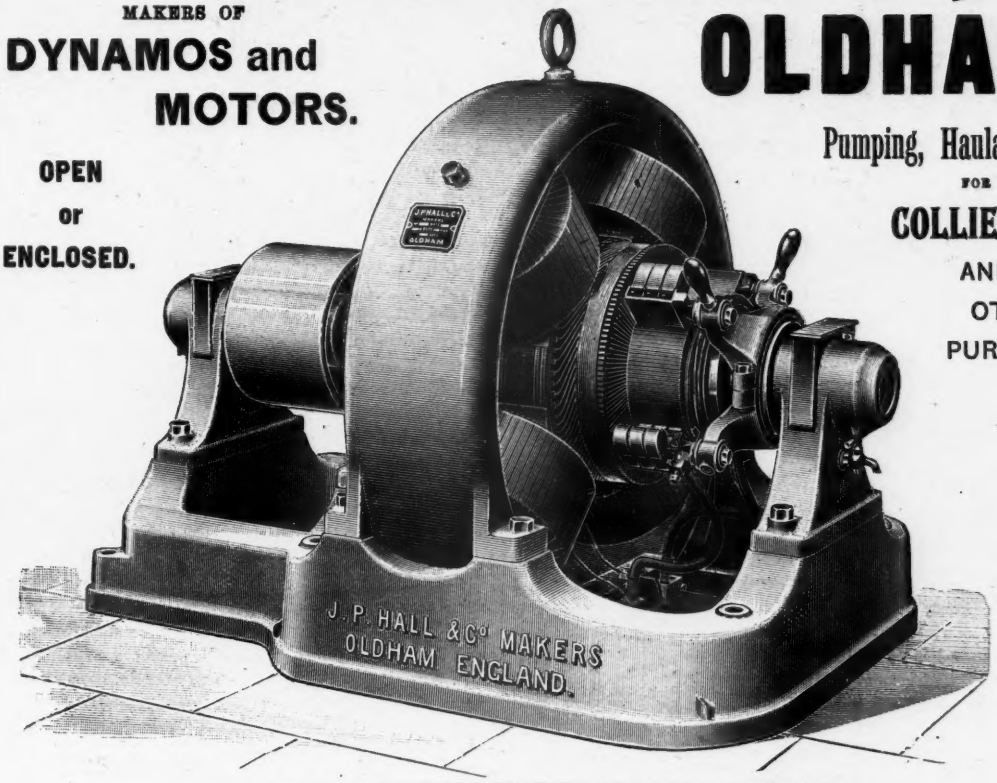

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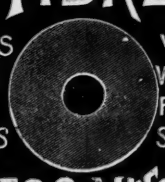

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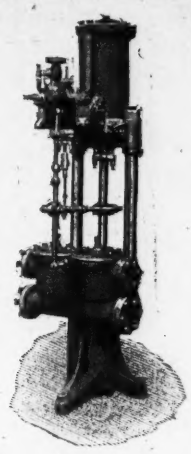

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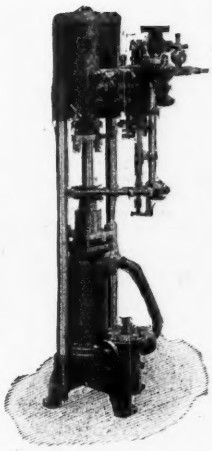

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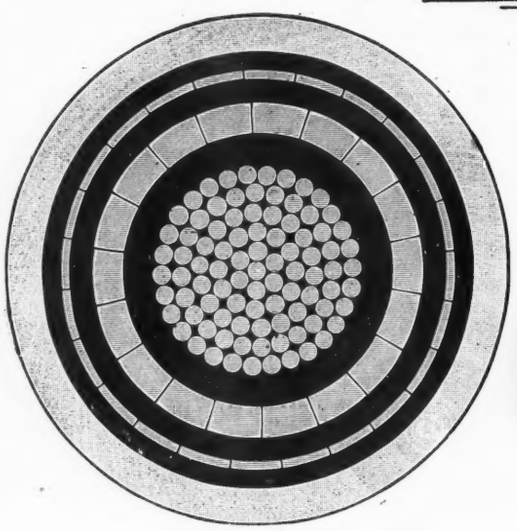

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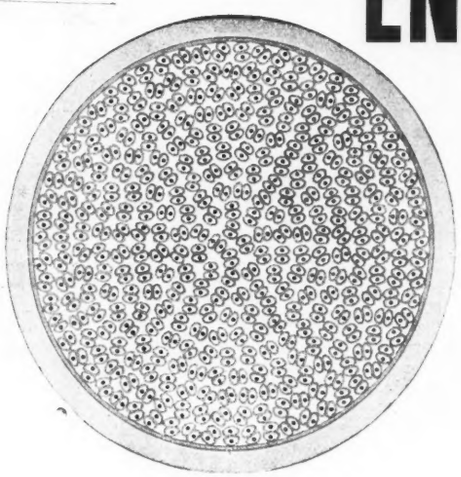

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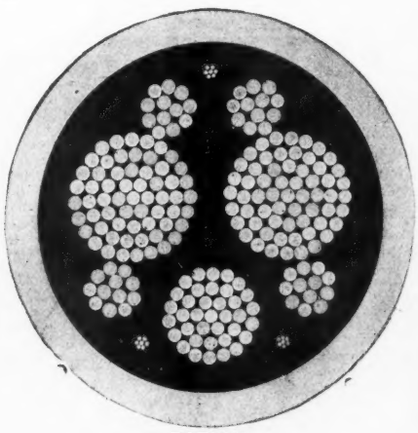

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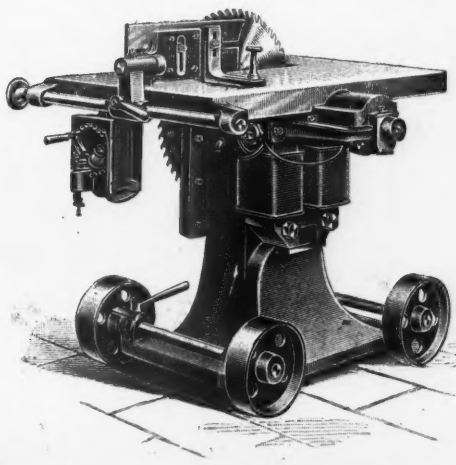

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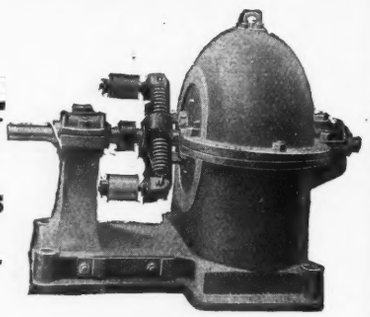

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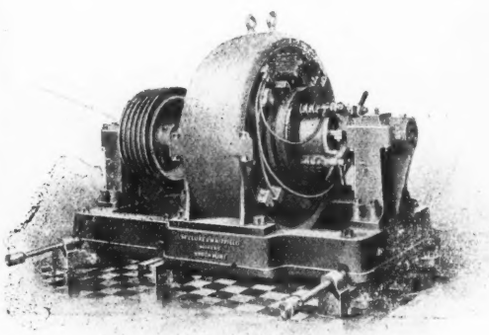

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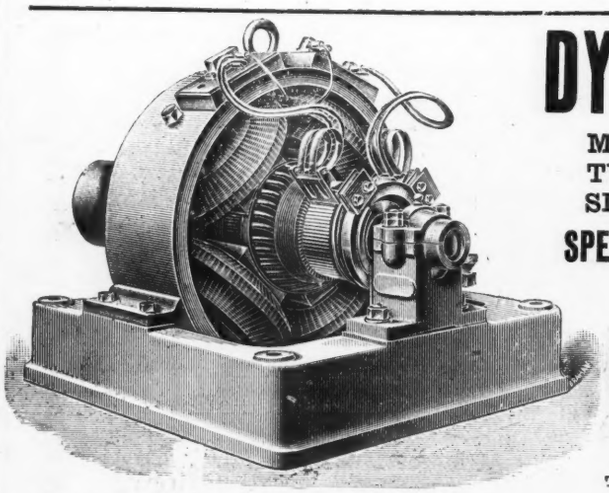

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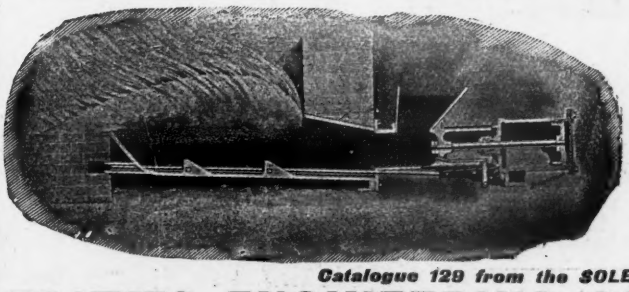

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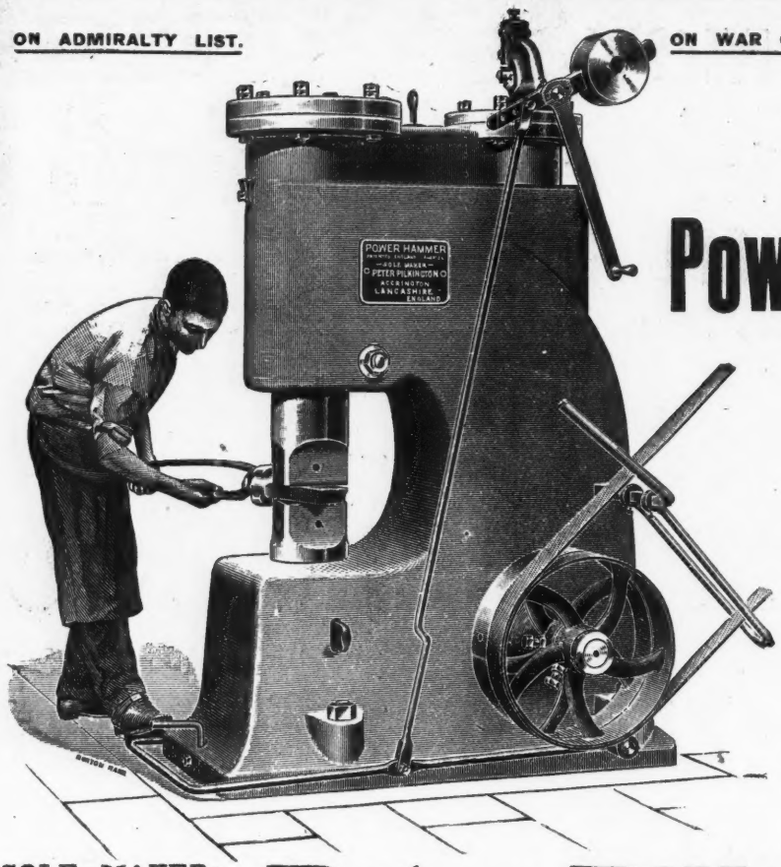

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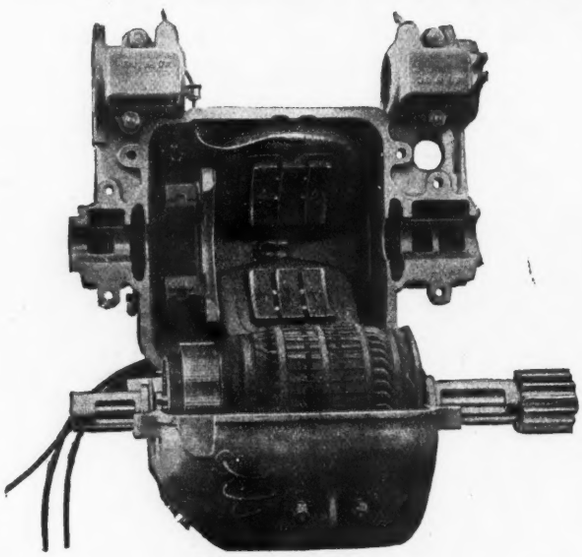

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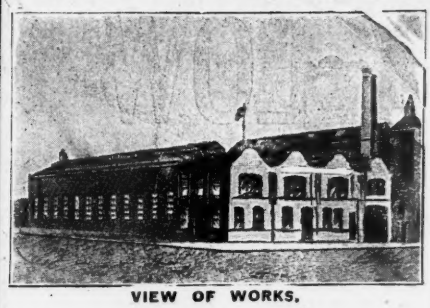

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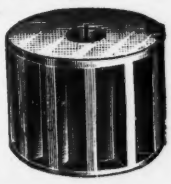

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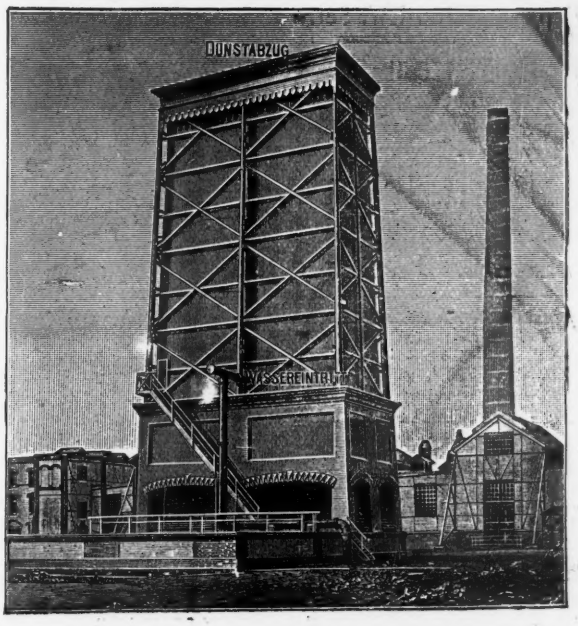

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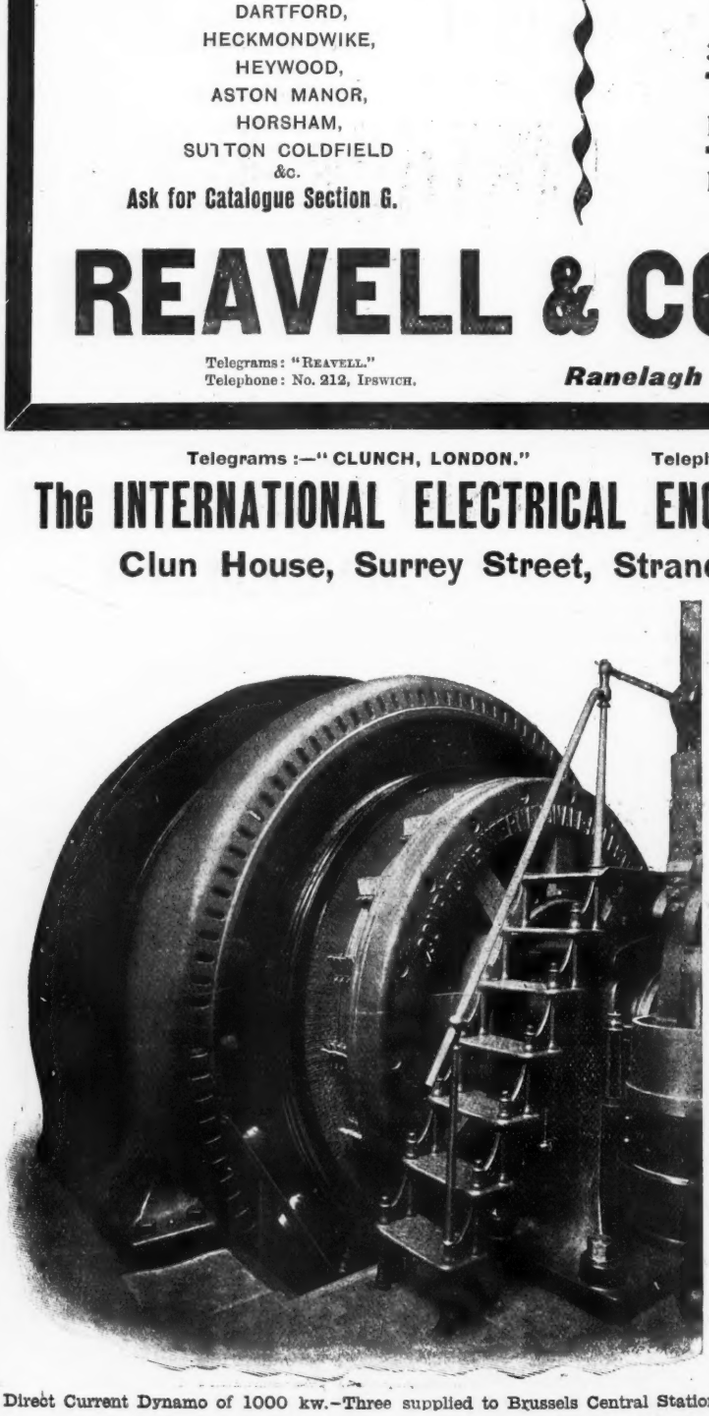

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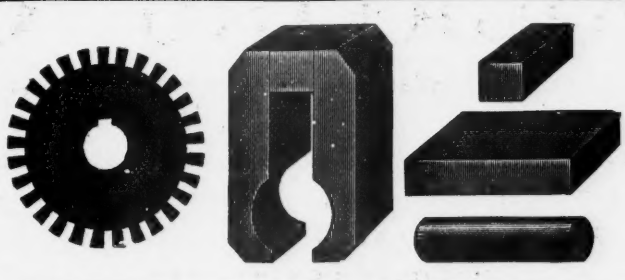

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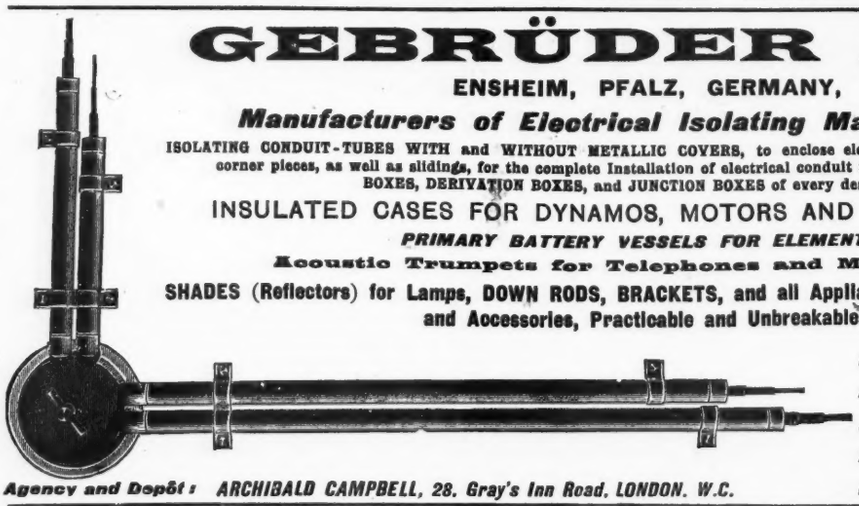

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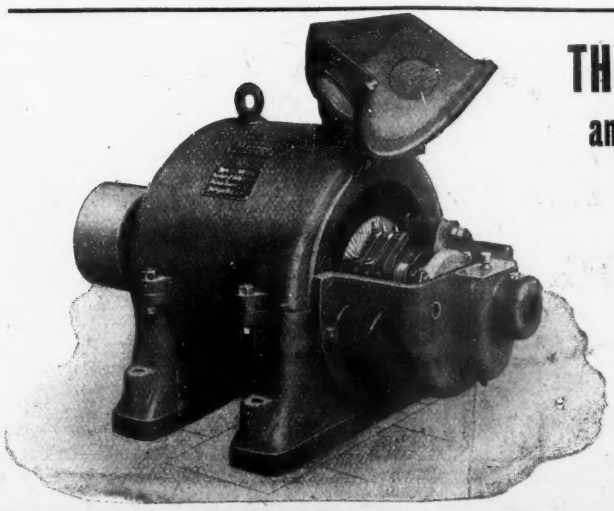

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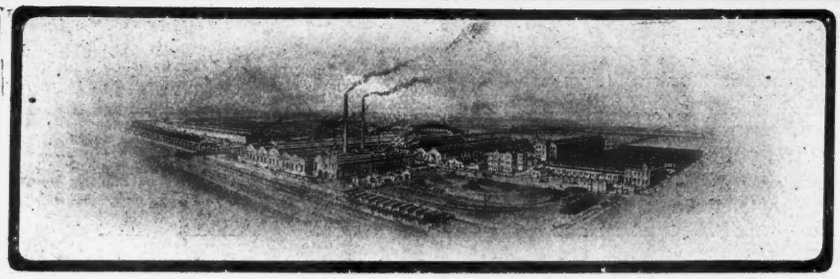

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PUBLIC APOLOGY

TO

THE SIMPLEX STEEL CONDUIT CO., Ltd.,

FROM

THE METALLIC SEAMLESS TUBE CO., Ltd.,

FOR

INFRINGEMENT OF THE "SIMPLEX" CO's. PRICE LIST.

PUBLIC APOLOGY.

To The Simplex Steel Conduit Co., Ltd.,
Coventry Street,
Birmingham

20th November, 1901.

WE, the undersigned, THE METALLIC SEAMLESS TUBE CO., Ltd., of Wiggin Street, Birmingham, admit that we have infringed your Illustrated Price List, which has been duly entered at Stationers' Hall.

In compliance with your demands, we have:—

(1) Furnished you with full particulars of the Price Lists issued by us, and have destroyed such Price Lists as have not been issued.

(2) Paid you a sum to cover the expenses incurred and to be incurred by you.

AND WE, THE METALLIC SEAMLESS TUBE CO., Ltd., and the undersigned, J. Goodman & Sons, of Castle Street, High Street, Birmingham, the Printers of the Price List, HEREBY APOLOGISE for the wrong we have done you, and authorise the publication of this apology by you within the next three months in such a way as you may think fit.

(Signed) THE METALLIC SEAMLESS TUBE CO., LTD.,
A. E. Evans, Secretary.

(Signed) JOHN GOODMAN & SONS.

The SIMPLEX STEEL CONDUIT CO., Ltd., HEREBY give notice that they are determined to protect their own and their customers' interests, by taking immediate action against all persons or firms infringing their **COPYRIGHTS**, or the designs of their **REGISTERED FITTINGS.**

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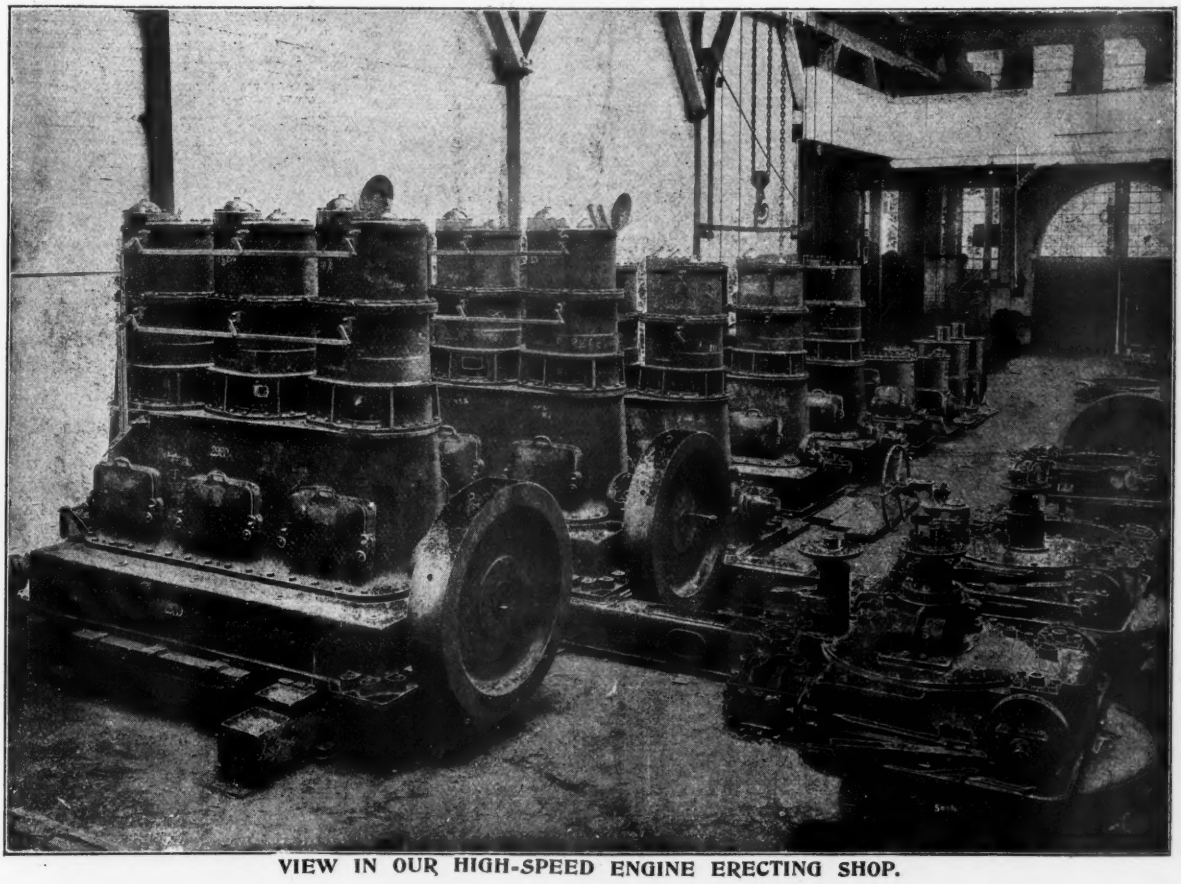

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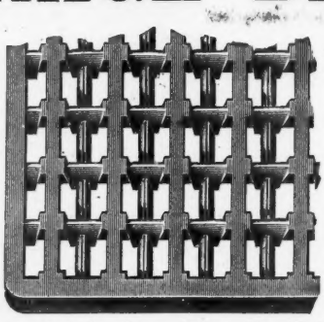

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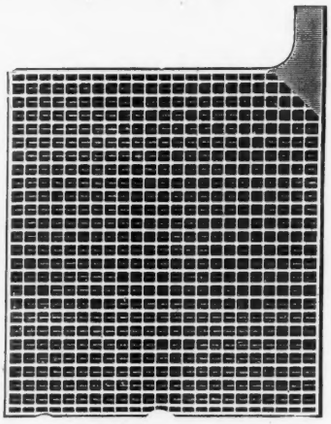

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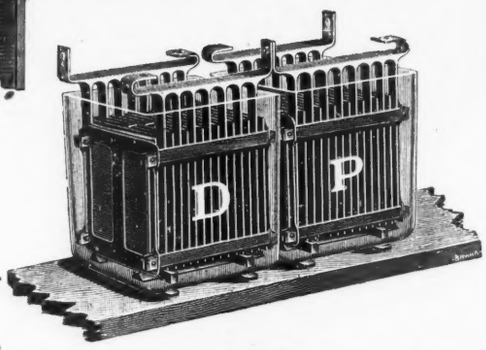

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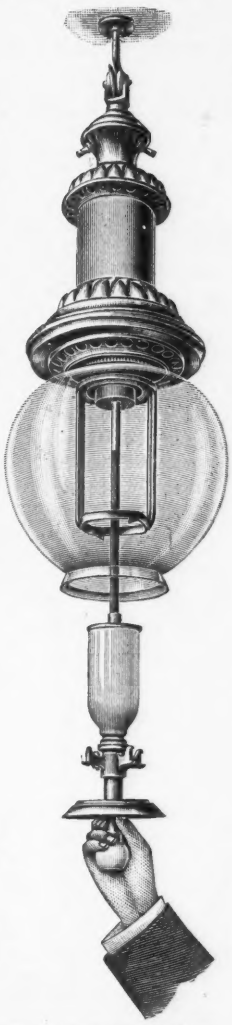

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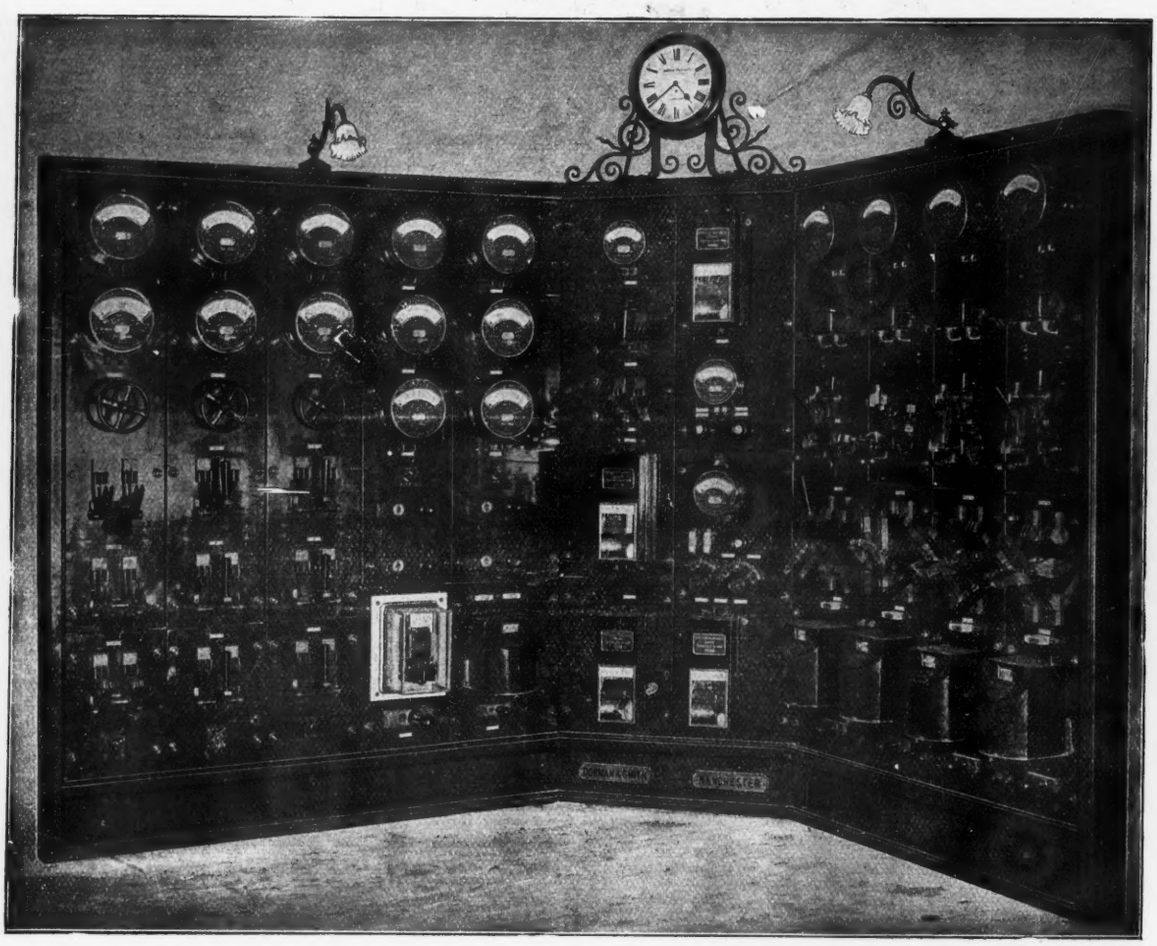

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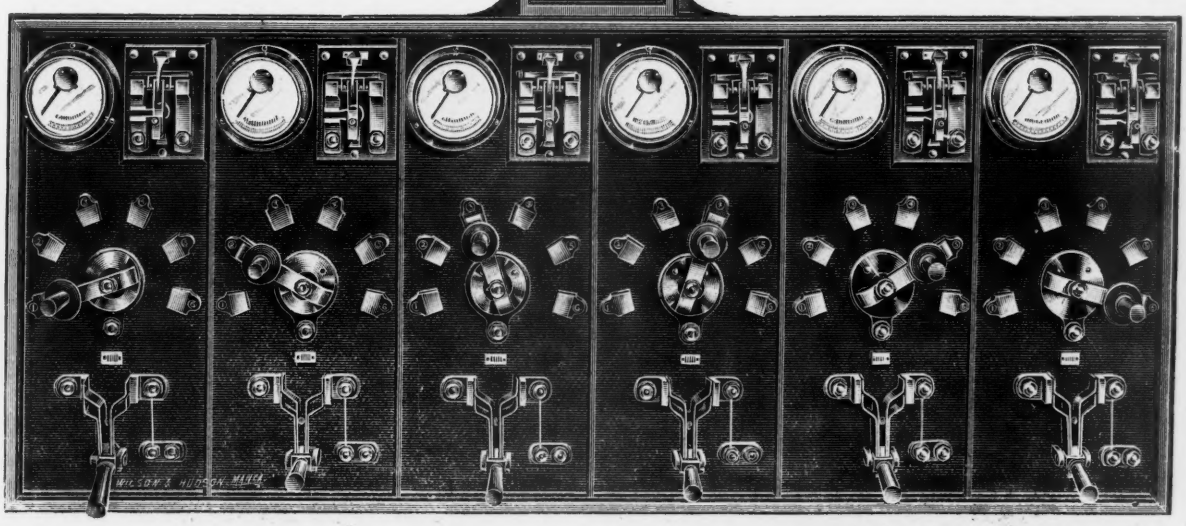

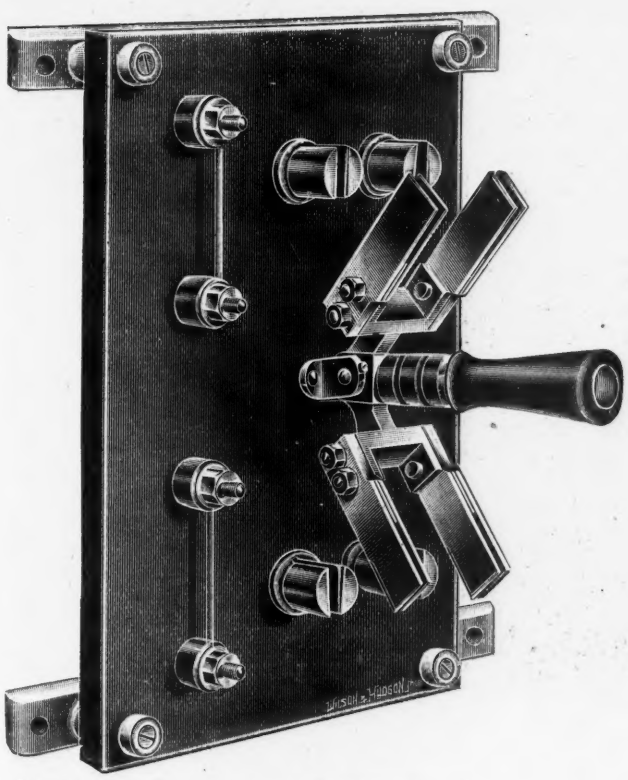

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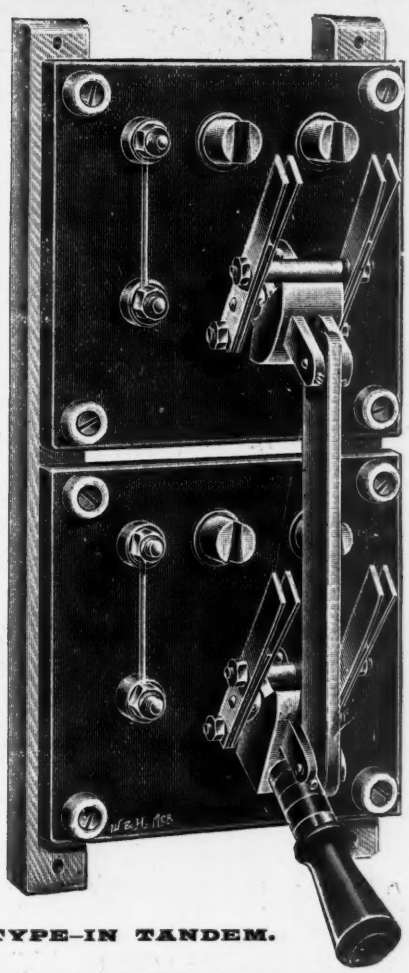

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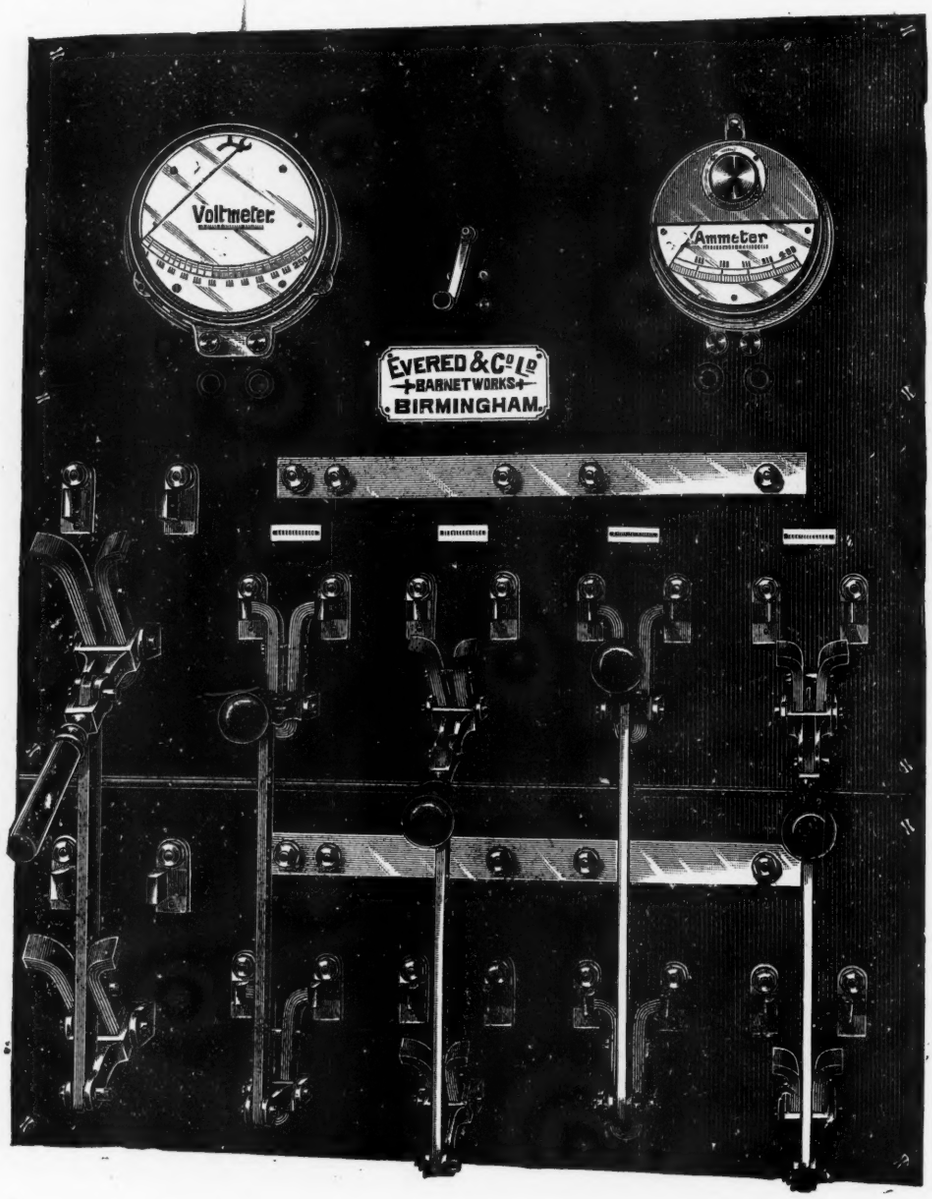

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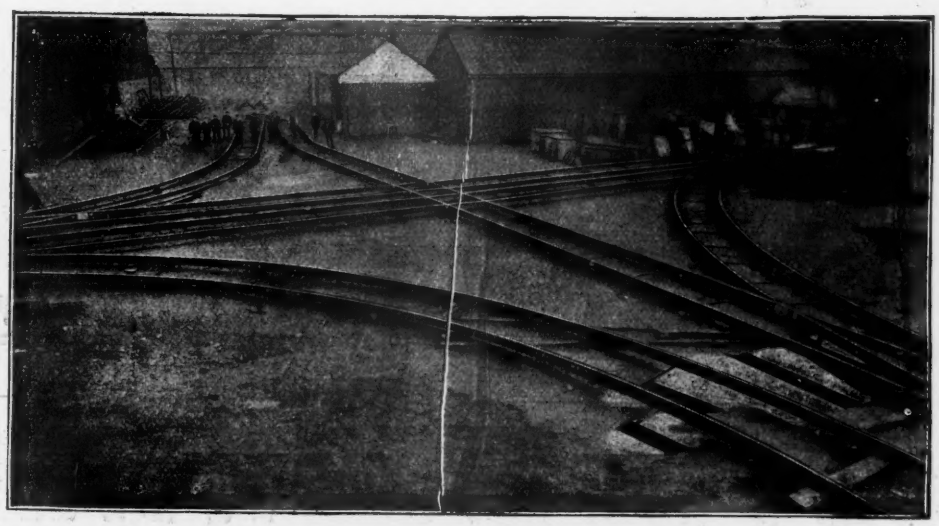

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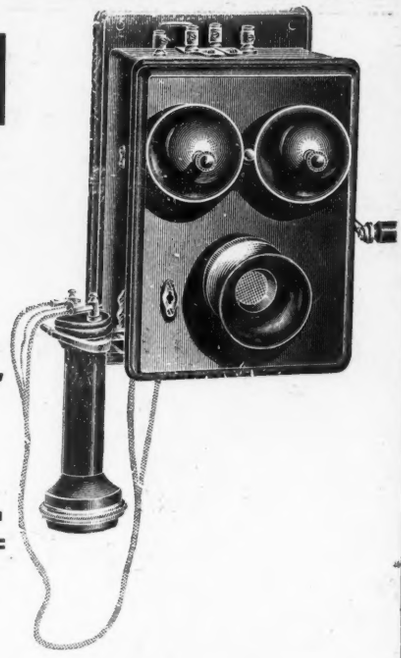

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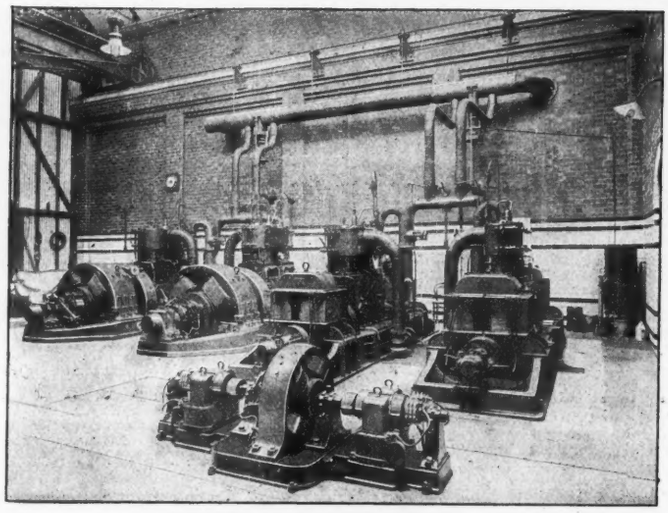

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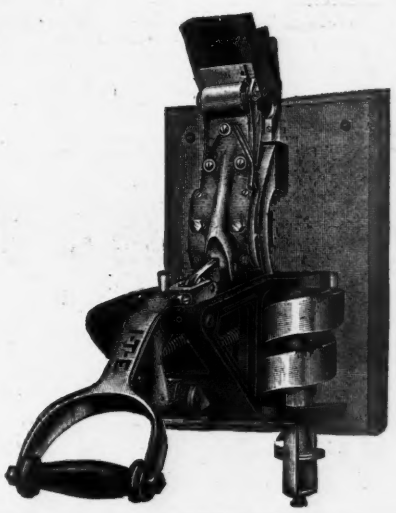

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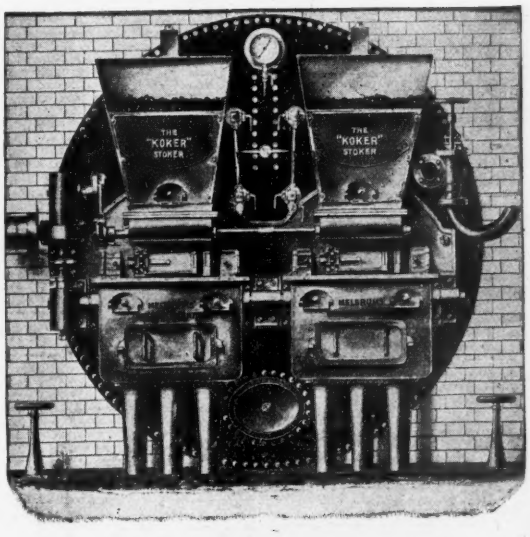

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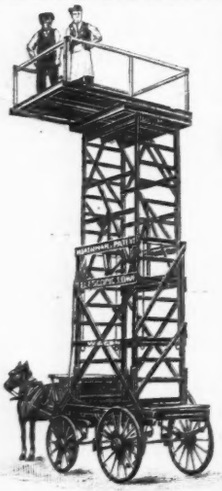

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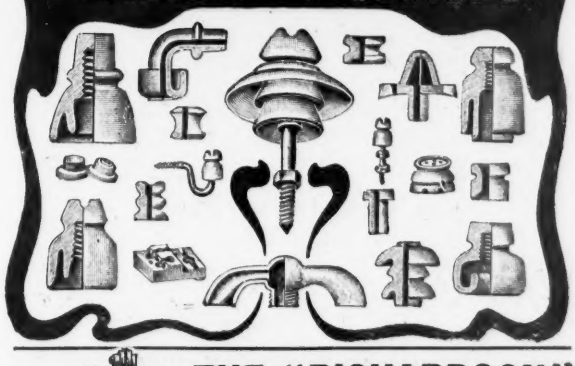

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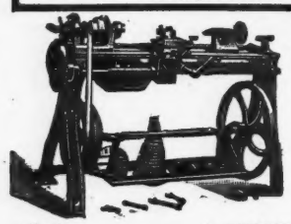

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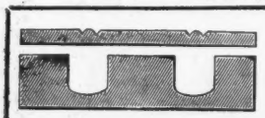

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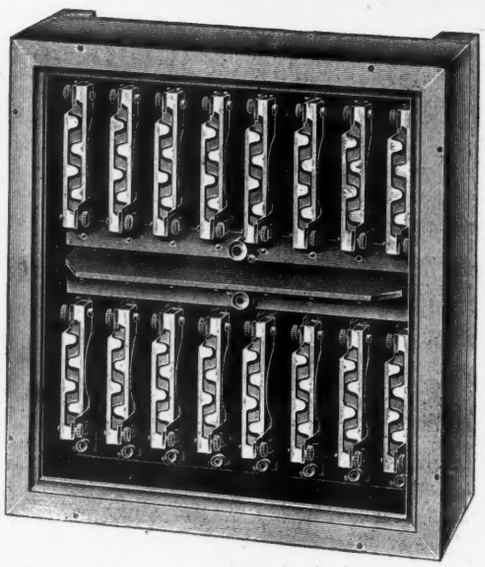

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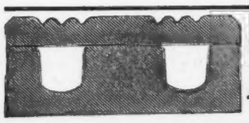

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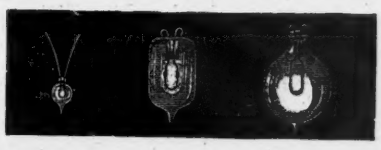

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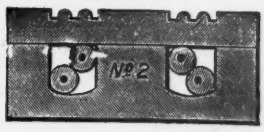

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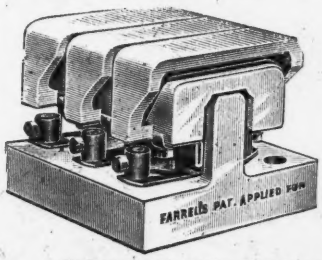

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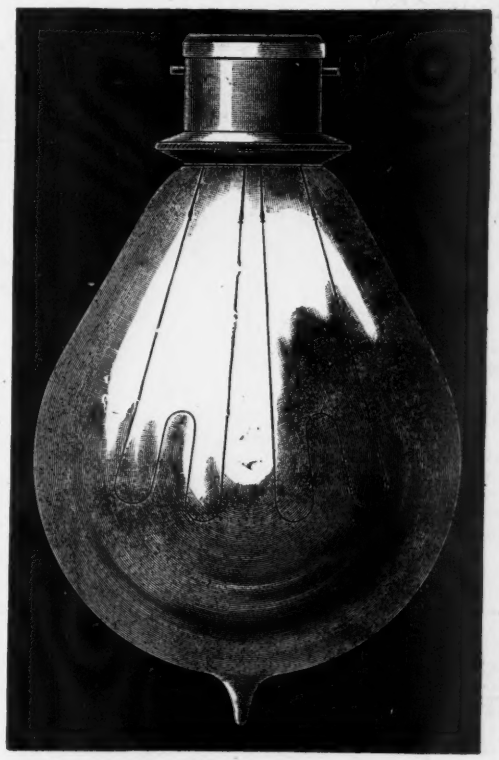

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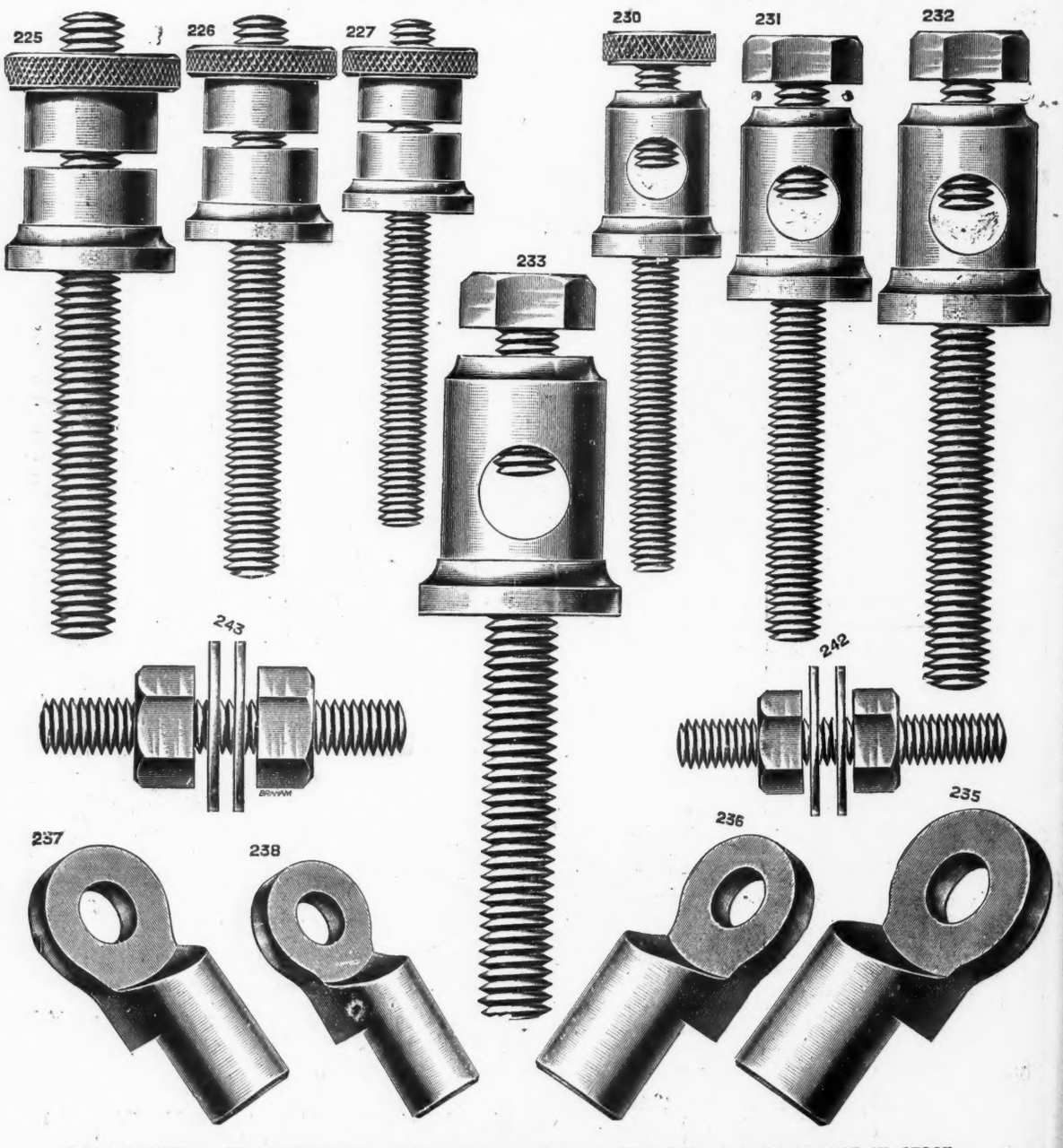

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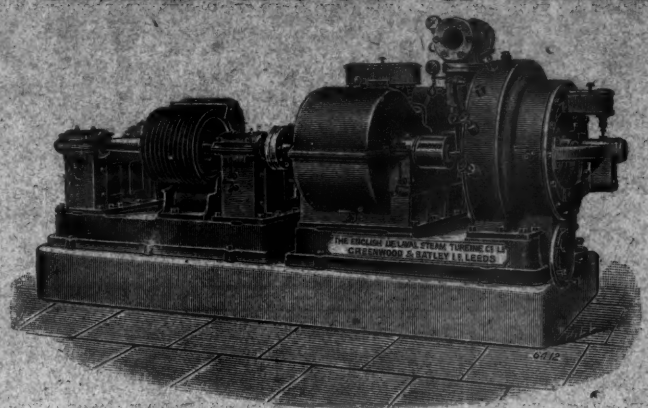

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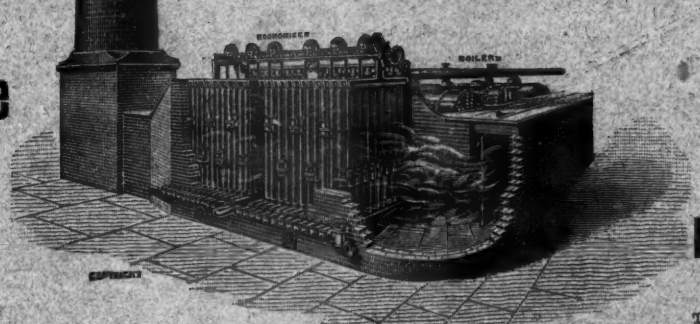

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